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NUCLEAR SCIENCE ABSTRACTS

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Vols. 16-20, Personal Authors (1962-1966). $22.50 (Available November 1, 1967).
Vols. 16-20, Corporate Authors (1962-1966). $3.75.
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Index References

All index entries refer the reader to volume and abstract number:

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FOURRIER, Alain
  Radioactive chain of mass number 189,  21:10023
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Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

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MONTH, M.
  Theory of gradient perturbations in AGS,  21:9872 (BNL-
    10899)
MONTH, Melvin
  Simple relativistic calculation of the electromagnetic
    form factors of the deuteron,  21:9744
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Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

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SHEEP
  radiation dosimetry in, measurement of lethal dose of x,
    21:8905(R) (AD-631189)
  radiosensitivity of hematopoietic system of, x,
    21:8905(R) (AD-631189)
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SHELTERS
  construction of, for civil defense,  21:8838
  design of fallout,  21:8777(R) (AD-629736)
  design of shaft closure for,  21:8563(P)
  determination of configuration of, for ventilation,
    21:8779(R) (AD-629926)
  equipment for fallout, minimal requirements of,
    21:8782(R) (AD-631424)
  evaluation of fallout, for fire and air blast damage,
    21:8560 (URS-658-3)
  fire resistance of components of, evaluation of,
    21:8789(R) (AD-642241)
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Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

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UNION CARBIDE CORP., OAK RIDGE, TENN.  Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
    storage containers,  21:8500 (Y-1561)
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Report Numbers

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TID-
  3311(Suppl.  21-8567   Dep. mn. CFSTI $3.00 cy, $0.65 mn
    2)
  22298        21-9915   Nucl. News, 9: No. 12, 17-21 (Dec.
                           1966)
  22298        21-9914   Nucl. News, 10: No. 1, 17-20(Jan.
                           1967)
  23267        21-9702   Phys. Rev., 152: 1171-82(Dec. 23,
                           1966)
  23287        21-8498   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23420        21-8764   Lancet, 2: 672-5(Sept. 24, 1966)
  23474        21-8528   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23478        21-8641   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23482        21-9471   Dep. mn. CFSTI $3.00 cy, $0.65 mn
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CHEMISTRY

Analytical Chemistry

Refer also to abstracts 32251 and 34119.

32080 (AAEC/TM-376) THE EMISSION SPECTROCHEMICAL ANALYSIS OF IMPURITIES IN PLUTONIUM DIOXIDE. Dale, L. S.; Hurst, H. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb. 1967. 19p. Dep.

A method for the analysis of impurities in plutonium dioxide is described. Plutonium is separated from its impurities by adsorption on to anion exchange resin. The effluent containing the impurities is spectrographically analyzed using a graphite spark technique. Pyrolytic graphite electrodes that are non-porous and do not require sealing are used in preference to the normal greased electrodes, which are unsuitable for the analysis of acidic solutions. The plutonium is analyzed for Fe, Al, Mg, Mn, Ni, Cr, Pb, Cd, Co, Ca, Sn, Mo, and Zn using vanadium as internal standard. The overall precision of the method is estimated to be ±20%. (auth)

32081 (AAEC/TM-377) THE DETERMINATION OF ^{90}Sr IN ENVIRONMENTAL MATERIALS. Davis, P. S.; Piper, N. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb. 1967. 16p. Dep.

A method for determining ^{90}Sr in environmental materials is described. It consists of the ion-exchange separation of strontium from calcium at an elevated temperature by careful control of pH and the molar ratio of Ca : EDTA, followed by scavenging. Activity of the ^{90}Sr is determined by counting the ^{90}Y daughter. Recovery of strontium is determined with ^{85}Sr tracer. Typical recovery of strontium is 70 to 90 per cent. Procedures are given for analysis of milk, vegetation, meat and fish, rainwater, and oyster shells and reference is made to analysis of oyster flesh, soil, and effluent. (auth)

32082 (AERE-AM-104) DETERMINATION OF YTTRIUM IN ALLOY STEELS. Spicer, G. S. (Atomic Energy Research Establishment, Harwell (England)). June 1967. 8p. Dep. CFSTI. UK 1s,2d.

A procedure is described that uses an isotope dilution technique to determine yttrium in steels which may also contain aluminum. The yttrium is separated as the fluoride and a source in suitable form prepared and counted. The specific activity of this source is compared with standards prepared from a known amount of yttrium. The method has been applied to 15/4/1 chromium–aluminum–yttrium steels and 20/25/1 stainless steels containing up to 1% of yttrium. The accuracy and precision have been determined at the 0.1 and 1% levels. A coefficient of variation of about 3% was obtained at both levels. The method was found to have a positive bias of 1% at the 1% yttrium level and 2% at the 0.1% yttrium level. (P.C.H.)

32083 (AERE-M-1889) THE PREPARATION OF PLUTONIUM CONTAINING SAMPLES FOR ELECTRON PROBE MICROANALYSIS. Chamberlain, H. E.; Hodkin, D. J. (Atomic Energy Research Establishment, Harwell (England)). May 1967. 12p. Dep. CFSTI. UK 1s, 9d.

Techniques based on normal metallographic preparation, and which do not involve surface coating, are described for the preparation of plutonium-containing samples for microanalysis. Samples can be examined with a non-active instrument without spread of contamination to operator or laboratory. (auth) (UK)

32084 (AERE-R-5461) AN EVALUATION OF SEVERAL GAS-CHROMATOGRAPHIC AND COLORIMETRIC METHODS FOR THE DETECTION OF IRRADIATED HORSE-MEAT. Hills, P. R.; Smith, A. H. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). Apr. 1967. 28p. Dep. CFSTI. UK 3s. 6d.

A simple method is described for the differentiation of irradiated and unirradiated horsemeat by gas-liquid chromatography. Although changes which occur during the storage of irradiated samples reduce its accuracy, a range of aged laboratory samples was successfully differentiated by measurement of the total volatile content. Recommendations are made for the evaluation of this method under practical conditions. A colorimetric method for the discrimination of recently irradiated beef, which has been described in the literature, was found unsuitable for samples of aged horsemeat. (auth) (UK)

32085 (CONF-661018) PROCEEDINGS OF THE 12TH ANNUAL BIO-ASSAY AND ANALYTICAL CHEMISTRY MEETING HELD AT GATLINBURG, TENNESSEE, OCTOBER 13-14, 1966. West, C. M. (comp.) (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). June 6, 1967. Contract W-7405-eng-26. 234p. Dep. CFSTI.

Separate abstracts were prepared for 15 papers. Four papers were abstracted previously and appeared in NSA Vol. 20 as number 10867, and in Vol. 21 as numbers 4440, 6486, and 10249. (B.H.S.)

For abstracts of individual papers see: 32086, 32087, 32558, 32559, 32636–32644, 32678, and 32734.

32086 (CONF-661018, pp 1-9) IMPROVED PROCEDURE FOR RADIOSTRONTIUM ANALYSIS OF HUMAN URINE. Farabee, L. B. (Oak Ridge National Lab., Tenn.).

The procedure used routinely for radiostrontium analysis at Oak Ridge National Laboratory was revised for greater efficiency and also for more extensive examination of an individual urine sample. An alkaline-earth-phosphate precipitation procedure was applied to co-precipitate both the alpha emitting actinide elements and radiostrontium. Improved efficiency for radiostrontium was attained by the addition of calcium, H_3PO_4, excess NH_4OH, and the exclusion of atmospheric CO_2 after precipitation. Revisions were made also in the cation exchange column separation of radiostrontium from calcium and magnesium using Na_4EDTA and citric acid. Use of these chelating and complexing agents reduced the time required for ^{85}Sr analysis by about 50%. (auth)

32087 (CONF-661018, pp 10-23) RAPID DETERMINATION OF BERYLLIUM BY A DIRECT-READING ATOMIC ABSORPTION SPECTROPHOTOMETER. Bokowski, D. L. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). (RFP-787).

A sensitive and specific analytical method for beryllium in air, wipe, biological, and packing material samples was developed. A single-beam atomic absorption spectrophotometer and high-temperature nitrous oxide–acetylene flame was used. The chemical technique for sensitivity enhancement and decontamination from radionuclides is described. Maximum time expenditure for an analysis was less than 30 minutes. Multiple samples were run in the same time period. Sensitivity of the method was less than 0.04 parts per million of beryllium with a repeatability of ~2% of the amount present. Decontamination factors for uranium and transuranium elements were greater than 5000. (auth)

32088 (EUR-3469,e) COMPUTER PROGRAM FOR ACTIVATION ANALYSIS WITH GERMANIUM LITHIUM DRIFTED DETEC-

TORS. Guzzi, G.; Pauly, J.; Girardi, F.; Dorpema, B. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 1967. 40p. Dep.

A computer program, ANGIR, especially developed for activation analysis problems is presented. This program is based on the measurement of photopeak surfaces of complex gamma spectra obtained by means of Ge(Li) detectors. Possible interferences from radioisotopes that give photopeaks that can be superimposed to that measured are evaluated, but not corrected. The program, written in FORTRAN for the IBM 7090, is used routinely for the determination of radioelements in biological specimens. The principles on which the program is based are given, and in appendices the necessary instructions for its use and the complete list are added. (auth)

32089 (KAPL-P-3339) LOW CURRENT DENSITY SPUTTERING ION SOURCE AND ITS APPLICATION TO THE ISOTOPIC AND QUANTITATIVE ANALYSIS OF NANOGRAM SAMPLES. McHugh, James A. (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 26, 1967. Contract W-31-109-eng-52. 22p. (CONF-670534-1). Dep. CFSTI.

From 15th Annual Conference on Mass Spectrometry and Allied Topics, Denver, Colo.

The process of generating secondary positive or negative ions of a material by ion bombardment was applied to small solid-sample analyses. A compact low current density ion source employing this technique was constructed. The applications, advantages, and limitations of this type of source in the field of analytical mass spectrometry are discussed. In addition, a method for the quantitative determination of ^{9}Be, which is based solely on the quantitative interpretation of ^{9}Be ion emission from the sputtering source, is presented. (auth)

32090 (TRG-Report-1496) SEPARATION OF NEODYMIUM FOR THE DETERMINATION OF THE BURN-UP OF NUCLEAR FUELS. Savage, D. J.; Drummond, J. L. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). Apr. 20, 1967. 12p. Dep. CFSTI. UK 1s. 9d.

A single-column anion exchange procedure using methanol–water–nitric acid solutions is described for the separation of neodymium. It is suitable for use in measurement of the burnup of irradiated nuclear fuel, using a mass spectrometric isotope dilution determination of the neodymium isotopes. The effect of variations in experimental conditions was studied to determine the robustness of the method and the tolerable limits of variation. The method is simple, robust and relatively rapid. It gives results for burnup with a coefficient of variation of better than 2%. (auth) (UK)

32091 (Y-KG-44) SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS OF URANIUM METAL. Franklin, J. C.; Griffin, E. B.; Catlett, C. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). [1967]. Contract W-7405-eng-26. 4p. (CONF-670534-2). Dep. CFSTI.

From 15th Annual Conference on Mass Spectrometry and Allied Topics, Denver, Colo.

Because of the sensitivity available and the range of elements desired, spark source mass spectrography was selected for the analysis of high-purity uranium having a total of about 30 wt ppM of impurities. The concentration of impurities measured varied from hundreds of parts per million before purification to a few parts per million after zone refining. A standard uranium sample was obtained and used for determining the major impurity elements. The analysis of the standard, preparation of calibration curves, data interpretation, sensitivity factors, and the precision of the method are discussed. (auth)

32092 RADIOMETRIC METHOD FOR GRAVIMETRIC ANALYSIS OF DUST CONCENTRATION. Aleksandrov, N. N.; Bogdanov, V. G. Tr. Gl. Geofiz. Observ., No. 185, 104-9(1966). (In Russian).

Radiometric determinations of dust thickness in a filter according to the absorption curves in aluminum were made using ^{137}Cs isotopes with $\Delta_{\frac{1}{2}} = 17$ mg/cm^2 and front-window Geiger counter with a mica window thickness of 2.1 mg/cm^2. The order of error of determination of the thickness by gravimetric methods was ±0.2 mg/cm^2 and by radiometric methods ±0.5 mg/cm^2. (tr-auth)

32093 RADIOACTIVE INHIBITOR TRACER IN PIPELINES. Riggs, Olen L. Jr.; Hutchison, Merle; Gant, Preston L. (Continental Oil Co., Ponca City, Okla.). Mater. Protect., 5: 27-9 (Nov. 1966).

A technique using radioactive tracers was developed to test the concentration of corrosion inhibitor in pipelines. The problem centered around 3 variables: concentration of inhibitor, level of radioactivity, and effective inhibition. These were adequately measured and a correlation developed among them. The ASTM D-665 rust test was chosen to determine the inhibitor efficiency vs concentration. A carrier for the inhibitor, heating oil (a colorless compound that gave no interference in radioactive analysis) was chosen. The Wilzbach tritium-labeling technique, was found unsatisfactory (due to the rapid exchange of hydrogen in the acid during the alcohol wash). A modified tritium-labeling technique was developed using the catalytic exchange of tritide with hydrogen at unsaturation positions of molecules. The technique proved successful and the product was made radioactive by this method. A liquid scintillation counter was used to determine the level of radioactivity in the inhibitor concentrations. One Curie of tritium added to the corrosion inhibitor gave a sensitivity of one ppM. (BBB)

32094 ANGULAR DEPENDENCE IN HONEY CONE COLLIMATOR. Honda, Takashi (Kanazawa Univ., Japan). Radioisotopes (Tokyo), 16: 6-13(Jan. 1967). (In Japanese).

The response profiles obtained by scintillation counting the various point sources (^{198}Au; 412 keV, ^{131}I; 364 keV, ^{203}Hg; 279 keV) moved perpendicularly to the axes of two focusing 37-hole lead collimators (5, 10 cm) in each optical focus plane. This transverse response profile was compared with a profile taken at various angle of collimator rotation. The difference of counting rate was remarkable at 30° to the direction of collimator rotation. It was determined that the edges of the area that is burned black in point source scintigram represent the region somewhere between 0.1% and 5% of the maximum response over the center. This suggested that it might be useful to define isoresponse down to very low levels, since it is obvious that such response can affect the appearance of scan records. A difference in response of as much as a factor of two at about 3 cm off-axis suggests a reason for the starfish-like scan of the point source. Fortunately, this is not a large effect because the volume of this response region is not large. It is, however, another factor in image distortion. This effect is obtained with most hexagonal arrangement of hexagonal or round holes. In studies involving ^{131}I it became apparent that the 638 keV gamma rays in ^{131}I was the major contributor to response to the 364 keV region, the higher-energy gamma rays penetrate the shield, make Compton interactions in the crystal, and cause frequent pulses accepted in the 364 keV region. (auth)

32095 ABUNDANCE OF ISOTOPES OF LEAD IN A ROCK SAMPLE OF THE DECCAN TRAPS AND ESTIMATE OF THE AGE OF THE ROCK FROM THE LEAD-RATIO. Khambata, S. J.; Miranda, M. D.; Saldanha, J. A. (St. Xavier's Coll., Bombay). Curr. Sci. (India), 36: 371-2(July 20, 1967).

Spectrochemical methods were used to analyze a rock sample for total lead concentration. The sample was also examined for the $^{207}Pb/^{206}Pb$ ratio for age estimation. The isotope ratio was 0.047, which gave (from a graph) the approximate age of 0.9×10^{9} yrs to the rock sample. (P.C.S.)

32096 DETERMINATION OF PROTEIN-BOUND IODINE (PBI) IN SERA FROM PATIENTS WITH VARIOUS THYROID DISEASES BY NEUTRON ACTIVATION ANALYSIS. Hamada, Satoshi; Torizuka, Kanji; Hamamoto, Ken; Nakagawa, Jun; Mori, Toru; Morita, Rikushi; Nakagawa, Tsuyoshi; Konishi, Junji; Miyake, Tadashi; Fukase, Masaichi (Kyoto Univ.). Radioisotopes (Tokyo), 16: 14-18(Jan. 1967).

Activation analysis was used for measuring protein-bound iodine (PBI) in serum and trace amounts of iodine. The samples of human serum were passed through an ion exchange column, and small amounts of ^{131}I were added for recovery check. Acid digestion was then carried out by adding chromium trioxide and sulfuric acid, and distillation followed after adding phosphorous acid and hydrogen peroxide. The iodine evolved was trapped in potassium hydroxide. An aliquot of the distillate was placed in a polyethylene ampoule, and was irradiated in the pile at a thermal neutron flux of 4×10^{12}n/cm^2/sec for either 15 or 30 minutes. The induced ^{128}I with added carriers was oxidized with chlorine bleach, reduced with $Na_2S_2O_5$, and then extracted with carbon tetrachloride after adding sodium nitrite. The carbon tetrachloride layer was washed with dil-H_2SO_4 and distilled water. Then ^{128}I was reduced to iodide with $Na_2S_2O_5$, precipitated with silver nitrate, and assayed in a multichannel pulse height analyzer and a Geiger-Mueller counter. This post-irradiation chemistry could be performed in approximately 30 minutes. The gamma spectrum and decay curve indicated the absence of nuclides other than ^{128}I and ^{131}I. PBI was determined on sera obtained from patients with thyroid diseases and normal subjects, and the values obtained were nearly the same as those by the chemical method. The duplicate determinations indicated good reproducibility. By this procedure, 2.9×10^{-9}g of the iodine can be measured. (auth)

32097 DETERMINATION OF LEAD IN ORE PULPS BY A TECHNIQUE USING TWO γ-RAY ABSORPTION GAUGES. Ellis, W. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales); Fookes, R. A.; Watt, J. S.; Hardy, E. L.; Stewart, C. C. Int. J. Appl. Radiat. Isotop., 18: 473-8(July 1967).

The lead concentration and density of ore pulps were determined using two γ-ray absorption gauges. One was a conventional density gauge using ^{137}Cs. The other was a lead-sensitive gauge, depending on the preferential absorption by lead of 225 keV γ rays from a novel source of Compton scattered ^{137}Cs γ-rays. It was shown by experiment that the accuracy of measurement of lead concentration is ±4% and of density ±0.9% for ore pulps with lead concentrations in the range 0.05 to 0.16 g/cm³ and densities 1.36 to 1.68 g/cm³. The gauges may be mounted directly on a flotation feed line. By simple electronic combination of the gauge outputs, a signal directly proportional to lead concentration may be obtained. (auth)

32098 DETERMINATION OF RADIOSULFATE IN BIOLOGIC FLUIDS AND TISSUES. Newton, William T.; Murphy, Josephine; Mullins, Lorine E. (Washington Univ., St. Louis. John Cochran Veterans Administration Hospital, St. Louis). J. Lab. Clin. Med., 69: 518-21(Mar. 1967).

Radioactive ^{35}S sulfate was precipitated from solution as the barium salt. The precipitate was resuspended in N, N'-dimethyl formamide and transferred quantitatively to a glass counting vial containing 10 ml toluene–phosphor reagent. After the contents of the vial were thoroughly mixed, dry silica powder was added to the vial in sufficient quantity to form a stable gel on mixing. Radioactivity was counted in the liquid scintillation counter at high efficiency over a wide range of precipitate mass. Formation of gel after the isotope was mixed in the counting vial allows uniform distribution of radioisotope with consequent improved reproducibility of determinations. (auth)

32099 RADIOACTIVE TRACER METHOD FOR DETERMINING PRASEODYMIUM IMPURITY IN CERIUM COMPOUNDS. Kostygov, A. S.; Saunkin, O. F. (State Scientific-Research and Planning Inst. of the Rare-Metals Industry, Moscow). Zavod. Lab., 33: 678-9 (1967). (In Russian).

A method is suggested for radioactive tracer control of high-purity cerium compounds during ion exchange purification of ammonium hexanitrocerate. Praseodymium impurities were determined with sensitivity up to 1×10^{-8}%. (tr-auth)

32100 RADIOACTIVE DETERMINATION OF TANTALUM IN A HIGH PURITY NIOBIUM PENTOXIDE. Alimarin, I. P.; Bilimovich, G. N.; Yakovlev, Yu. V. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zavod. Lab., 33: 672-6(1967). (In Russian).

A direct γ-spectrometric method was developed for determining up to 1×10^{-4}% Ta in Nb_2O_5. A radiochemical separation of smaller amounts from irradiated specimens is described. Extraction of $(C_6H_5)_4AsTaF_6$ by chloroform achieved the sensitivity of 1×60^{-6}%. (R.V.J.)

32101 ORGANIC ^{131}I COMPOUNDS RELEASED FROM A NUCLEAR FUEL CHEMICAL PROCESSING PLANT. Haller, W. A.; Perkins, R. W. (Pacific-Northwest Labs., Richland, Wash.). Health Phys., 13: 733-8(July 1967). (BNWL-SA-620).

Organic radioiodine compounds present in the gaseous effluent from Hanford's Purex Plant for nuclear fuel processing were fractionated by gas chromatography and measured by gamma spectroscopy. Analysis of the effluent for organic iodine-131 showed a complex mixture of active compounds with boiling ranges of 40 to 255°C; the lower boiling compounds were identified as alkyl iodides. (auth)

32102 THE DETERMINATION OF HEAVY WATER WITH THE UR 10 SPECTROPHOTOMETER. Kocent, Alexander; Vasatkova, Jirina (Cancer Research Inst., Brno). Jena Rev., No. 4, 228-9(1966).

A UR 10 spectrophotometer was used for the determination of D_2O by a method that permits analysis of H_2O and D_2O in any mixing ratios. Measurements were carried out at a wavelength of 1.41 μm (1050 cm^{-1}) where the absorption band of H_2O lies and at 1.65 μm (1005 cm^{-1}) where the HOD-band of the H_2O and D_2O mixture occurs. Concentrations at both wavelengths were determined independently and the mean value calculated. (J.G.B.)

32103 A SPECIFIC SPECTROFLUORIMETRIC DETERMINATION OF TERBIUM AS ITS EDTA-SULPHOSALICYLIC ACID COMPLEX. Dagnall, R. M.; Smith, R.; West, T. S. (Imperial Coll. of Science and Tech., London). Analyst, 92: 358-63(June 1967).

The ternary complex formed by terbium with EDTA and sulphosalicylic acid was used as the basis of a spectrofluorimetric determination of between 6.4×10^{-3} and 3.2 μg of terbium per ml. The system absorbs radiation characteristic of sulphosalicylic acid (about 320 mμ) and emits the band fluorescence of sulphosalicylic acid (410 mμ), together with the sharp line emission characteristic of terbium(III) (545mμ). The determination carried out with 4×10^{-3} M EDTA and 2×10^{-3} M sulphosalicylic acid in aqueous solution at a pH of between 11.6 and 11.9. No interference resulted from 50-fold molar excesses of the other rare earth ions, 33 other metal ions, or 14 anions. The fluorescence was not subject to oxygen quenching, was stable for several days, and had a temperature coefficient of −0.87 percent per °C. Analytical results obtained with prepared samples are given. (auth)

32104 ISOTOPE IDENTIFICATION BY AUTORADIOGRAPHY. Bishop, M.; Fletcher, K. E. (British Aluminium Co. Ltd., Gerrards Cross, Eng.). Int. J. Appl. Radiat. Isotop., 18: 465-71(July 1967).

Autoradiography was used to selectively identify radioisotopes in the presence of others, by determining characteristic energies and half-lives. Activities were assessed by densitometry, assuming a linear relationship between activity and density. The limited region of linearity was established from sensitometric curves. Density measurements were made with a microphotometer. The scope of the method is exemplified by identifications of ^{185}W, ^{60}Co, ^{32}P, ^{198}Au, and ^{51}Cr. (auth)

32105 ANALYSIS OF PETROLEUM PRODUCTS BY ABSORPTION OF RADIOACTIVE RADIATIONS. V. RADIOACTIVE ABSORPTION METHOD AND APPARATUS FOR THE CONTINUOUS ANALYSIS OF THE HETEROATOM CONTENT OF LIQUID PETROLEUM AND PETROCHEMICAL PRODUCTS. Balint, T. (Hungarian Mineral Oil and Natural Gas Research Inst., Veszprem). Acta Chim. Acad. Sci. Hung., 52: 243-50(1967).

A method for the continuous analysis of petroleum products by absorption of radioactive radiation is given. An apparatus is described that regulates the continuous surface density thus allowing the radiation absorption to depend only on composition of sample. The method described allows density compensation on a mechanical principle when the changes of density are neither too large (they do not exceed the value of ±0.05 to 0.10 g/ml) nor negligibly small. If sudden great density changes are expected, the regulating and measuring vessels must be in parallel. Compared to other methods, the apparatus has many advantages. The appreciable sensitivity toward density changes must be emphasized. Other advantages are the minimal sensitivity toward the velocity of flow of the liquid to be analyzed and the possibility of elimination of error source emerging from the change of distance between radiation source and detector. The apparatus is simple in construction and seems to be suitable for industrial uses. (D.H.M.)

32106 NEUTRON ACTIVATION DETERMINATION OF SCANDIUM IN METEORITES WITH APPLICATION OF SUBSTOICHIOMETRIC SEPARATION AND γ-SPECTROMETRY. Lavrukhina, A. K.; Kalicheva, I. S.; Kolesov, G. M. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 6, 651-4(June 1967). (In Russian).

A simple highly sensitive (up to 10^{-5}%) method of the neutron activation determination of scandium in meteorites using substoichiometric chromatographic separation and γ spectrometry is discussed. Scandium content was determined in specimens of the Yardymlinsk and Sikhote–Alin iron meteorite rains and in stony meteorites-chondrites. (auth)

32107 ON THE USE OF ^{15}N IN THE SOLID PHASE FOR THE DETERMINATION OF RADIOGENIC ARGON. Zadorozhnyi, I. K.; Volynets, V. F. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 6, 664-70(June 1967). (In Russian).

The use of nitrogen-15 in the solid phase as a tracer in determining the radiogenic argon content in minerals was investigated. It is shown that the method has a number of substantial defects. A modification of the method is proposed in which the defects are partially eliminated. The method can be used to determine radiogenic argon in samples with relatively high content. (auth)

32108 SIMPLE RADIOISOTOPE ASSAY FOR PHENYLALANINE HYDROXYLASE. Guroff, Gordon; Abramowitz, Amnon (National Institutes of Health, Bethesda, Md.). Anal. Biochem., 19: 548-55(June 1967).

An isotopic assay for phenylalanine hydroxylase activity was devised. The assay involves incubation of the enzyme with p-tritio-L-phenylalanine followed by the addition of N-iodosuccinimide to iodinate the tyrosine produced. The tritium released by this combination appears as tritiated water and is proportional to the amount of phenylalanine hydroxylated. Among the advantages of this method are its speed, simplicity, applicability to crude preparations, and utility in studies of the effects of p-phenols on hydroxylating systems. (auth)

32109 COLLECTION OF $^{14}CO_2$ FOR SCINTILLATION COUNTING BY A MODIFICATION OF THE VAN SLYKE PROCEDURE. Weyman, Albert K.; Williams, John C.; Plentl, Albert A. (Columbia Univ., New York). Contract I-225. Anal. Biochem., 19: 441-7(June 1967).

A method for the collection of CO_2 for scintillation counting is described in which a simple absorption unit is used as an accessory to the Van Slyke–Neill blood gas apparatus. Carbon dioxide was absorbed directly in the scintillation vial immediately after the determination of the total CO_2 content of the samples. The procedure was tested for varying sizes of samples and absorbents. Phenethylamine was superior to Hyamine as shown by statistical analyses of the data and the higher counting efficiency. The technique is applicable to standard procedures for blood and blood filtrates where labeled carbon dioxide may be liberated by chemical or enzymic means. (auth)

32110 SOME PROBLEMS IN THE SEPARATION OF TRACES OF ELEMENTS BY PRECIPITATION. IV. SEPARATION THROUGH THE CARBONATES: ITS USE IN DETERMINING TRACE CONTAMINANTS IN URANIUM COMPOUNDS. Upor, E.; Nagy, Gy. Acta Chim. Acad. Sci. Hung., 52: 235-42(1967).

The possibility of separation through the carbonates was studied for use in the determination of traces of elements present in uranium compounds or in substances of high uranium contents. It was found that the elements examined, with the exception of selenium, can be separated from uranium by treatment with hot 0.1M sodium carbonate in the presence of ferric hydroxide or aluminum hydroxide used as the carrier. On this basis, a semiquantitative method of spectral analysis was evolved. The influence of the pH on the adsorption of zirconium, thorium, lanthanides, and zinc was examined. The results constitute a potential basis for the analytical utilization of other separation process (such as that of uranium from zirconium, uranium from thorium, etc.). (auth)

32111 DETERMINATION OF TRACES OF ALUMINUM AND MANGANESE IN ZIRCONIUM AND ITS ALLOYS. Hashitani, Hiroshi; Katsuyama, Kazuo; Sagawa, Chiaki; Motojima, Kenji (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 16: 596-601(June 1967). (In Japanese).

A method for the determination of aluminum and manganese in a reactor material, Zircaloy-2, which contains 1.20 to 1.70% of Sn, 0.07 to 0.20% of Fe, 0.03 to 0.08% of Ni, and 0.05 to 0.15% of Cr, was established. The method can be used for determining down to 5 ppM of both aluminum and manganese in zirconium-bearing materials. Up to 2 g of the sample is dissolved with sulfuric acid and ammonium sulfate. Prior to the determination, zirconium is removed by extracting its cupferron chelate with chloroform. From 1 to 2N sulfuric acid solution, not more than 400 mg of zirconium is extracted, while aluminum and manganese remain quantitatively in the aqueous solution. The extraction should be carried out twice to eliminate zirconium completely. Fifteen ml of 8% cupferron solution is used for each 100 mg of zirconium at the first extraction, and 3 ml of the same solution is used at the second extraction. After removal of zirconium and decomposition of the residual cupferron, aluminum is determined by extracting its 8-hydroxyquinoline (oxine) complex from a solution (pH 5.0 ± 0.2) containing cyanide, and by measuring the absorption at 390 mμ. Chromium must be removed by extracting from a solution of pH 5.0 ± 0.2 as its 2-methyl oxine complex, before the aluminum determination. Manganese is determined on another aliquot which has been treated with cupferron, by extracting its 2-methyl oxine complex and by measuring the absorbances at 395 and 580 mμ. Interferences from chromium, nickel, and lead are eliminated by adding citrate, cyanide, and EDTA as masking agents to the aqueous solution (pH 12 ± 0.5). (auth)

32112 DETERMINATION OF NATURAL RADIOELEMENTS (URANIUM, ^{226}Ra, ^{210}Pb, AND ^{210}Po) IN THE URINE OF EXPOSED INDIVIDUALS. Zsoldos, Tibor; Csoevari, Sophia. Magy. Kem. Foly., 73: 228-32(May 1967). (In Hungarian).

Precipitation by the same reagent and the determination of natural uranium, ^{226}Ra, ^{210}Po, and ^{210}Pb in the presence of one another are described; the method is applicable to the analysis of the urine of exposed persons for these radioelements. Uranium is quantitatively precipitated by tannic acid in the presence of calcium carrier, and is determined, after processing the precipitate, photometrically in the form of the U(IV)–arsenazo-III complex. The accuracy of the method is 98 ± 5%. The solubility product of UO_2-m-galloyl gallate was determined, the presumed structure of the compound is given, and the stability of U(IV)–arsenazo-III complex in time is reported. By the use of Ba and Te as well as Bi and Pb carriers, the precipitation of trace quantities of ^{226}Ra, ^{210}Po, ^{210}Bi, and ^{210}Pb can also be achieved. The processes of pretreatment for these radionuclides are the same as those used for uranium. ^{226}Ra is determined by scintillation counting or by the measurement of radon in an ionization chamber; ^{210}Po is separated from the dissolved precipitate by spontaneous deposition; and ^{210}Pb is determined by measuring the β-radiation of ^{210}Bi. (auth)

32113 X-RAY FLUORESCENCE ANALYSIS OF LOW CONCENTRATIONS. THE ECONOMIC ASPECT: USE IN THE CONTROL OF NIOBIUM PRODUCTION. Gonzales, R.; Muratori, E.; Frere, P.; Durand, R. Mem. Sci. Rev. Met., 64: 403-11(Apr. 1967). (In French).

X-ray fluorescence was used for the analysis of trace amounts of Ta, W, Mo, Zr, Ti, Ni, and Fe in Nb. Results compared favorably with those obtained by chemical, radiochemical, and ultraviolet emission spectrographic methods. X-ray fluorescent analysis was also judged economical when compared with the other methods. (J.G.B.)

32114 TRITIUM MEASUREMENT BY GAS COUNTING. Yoneda, Kazuo; Kigoshi, Kunihiko (Gakushuin Univ., Tokyo). Bunseki Kagaku, 16: 561-5(June 1967). (In Japanese).

A procedure is given for measurement of tritium by proportional beta counting on the ethane gas prepared from hydrogen and acetylene. The results of studies on the method of preparation of a palladium catalyzer and memory effect are reported. Residual counting rate after the preparation and the measurement of high-level tritium, i.e., memory effect, is usually within 1% of initial counting rate, but is reduced to less than 0.01% by the change of catalyzer and repeated flushing of counting gas in the counter. Using a counter of 1 liter volume with shielding by anticoincidence counter, the proportional counting of ethane gas gives good and stable counting characteristics with 1 cpM for 92 T. U. under the filling of 1 atm C_2H_6. (auth)

32115 METHODS FOR THE SIMULTANEOUS DETERMINATION OF THE RADIOACTIVITY OF ^{3}H AND ^{14}C BY USE OF TRACER ATOM METHODS. Tykva, Richard (CSAV, Prague). Chem. Listy, 5: 690-708(1967). (In Czech).

The methods presently used for the simultaneous determination of ^{3}H and ^{14}C in labeling studies are described. They were divided, according to the type of radionuclide, into three groups: methods with separate determination of the activity after separation of the sample into two parts corresponding to the radionuclides to be measured; methods based on the absorption of the radiation (windowless 2π flow-through counters and autoradiography); and methods that make possible a separation with the help of the amplitude spectra of the registered voltage pulse (liquid scintillators, internal gas counter tubes, and windowless 2π flow-through counters). The basic properties of the methods were compared and examples of labeling operations are given. (tr-auth)

32116 BODY COMPOSITION OF LIVE ANIMALS AS DETERMINED BY ^{40}K. I. A CRYSTAL-TYPE, WHOLE-BODY COUNTER FOR DETERMINING BODY COMPOSITION OF LIVE ANIMALS. Johnson, James E.; Ward, Gerald M. (Colorado State Univ., Fort Collins). J. Dairy Sci., 49: 1163-5(Sept. 1966).

The use of a whole-body counter to measure burdens of fallout radionuclides and ^{40}K, and for estimation to lean-body mass (LBM), is discussed. The γ spectrum from a 450-kg Holstein cow is shown. The area under the ^{40}K peak is proportional to total-body ^{40}K and, hence, to total-body potassium. For ^{40}K calibration, slaughter and rendering experiments were used to determine total-body potassium, fat, and lean meat. The K concentration in LBM, as derived from the rendering experiments, was 65.5 meq/kg LBM. The calibration figure for a 450-kg Holstein cow was 4.0 counts per 30 min/g of body potassium. Results of 12 weekly counts on a 545-kg Holstein cow indicated the mean estimate of total-body potassium was 1414 g and the coefficient of variation, 2.82. A major problem expected was the γ contribution from reticulo-rumen contents and other parts of the gastrointestinal tract, especially from fallout radionuclides from feed, ^{137}Cs, Ce–^{141}Pr, ^{125}Sb, ^{131}I, ^{103}Ru, ^{106}Ru, Zr–^{95}Nb, ^{54}Mn, and Ba–^{140}La. The in vivo γ spectrum of a Holstein weighing 475 kg, fed green-cut alfalfa after May 15 and counted on June 7, 1965, is shown, as well as the γ spectrum of feces taken at the same time from this cow. In the latter spectrum, ^{137}Cs was completely obscured by shorter-lived γ emitters. Only ^{137}Cs and Ba–^{140}La are absorbed to any great extent, and fallout materials in the gut contents make little contribution to the whole-body γ-ray spectrum. The only interference with the ^{40}K photo peak is due to Ba–^{140}La. This, however, can be corrected by spectrum-stripping techniques and, in addition, Ba–^{140}La has a very short half-life (12.4 days). (BBB)

32117 ACTIVATION ANALYSIS WITH THE USE OF THE MATRIX METHOD. Plaksin, I. N.; Starchik, L. P.; Tustanovskii, V. T. Dokl. Akad. Nauk SSSR, 172: 104-6(Jan. 1, 1967). (In Russian).

Programming activation analysis data on the basis of matrices makes it possible to carry out necessary calculations on a computer. The coefficients of the matrix equations may be determined from the measurement of pulses at various photopeak areas. Supplementary measurements increase the reliability of the identification of isotopes present in the specimen and are very useful to resolve questions concerning complex decay schemes. These measurements help establish as many equations as there are un-

knowns; they are often encountered in the analysis of elements of composite nuclei with varying half lives. Thus, in the determination of rare earths by the (n,2n) reaction with 14 Mev neutrons, the product nuclei may be easily divided in 2 groups with widely differing half lives: ^{159m}Tb, ^{167m}Er, ^{89m}Y, with half lives of the order of seconds, and a second group, ^{140}Pr, ^{143m}Sm, ^{139m}Ce and ^{141m}Nd, with half lives of the order of minutes. Specific matrix values may also be used for comparing various activation analysis schemes. Standard computer programs may be used to transform the linear algebraic equation systems into equivalent systems with positively determined matrix coefficients. (TTT)

32118 DETERMINATION OF HAFNIUM CONCENTRATION IN ZIRCONIUM. II. Onosov, A. I.; Perovskii, A. P. Radiokhimiya, 9: 271-3(1967). (In Russian).

A neutron activation method for determination of the concentration of hafnium in binary mixtures of Zr–Hf is described, during which the different lifetimes of the intermediate states of ^{95}Zr and ^{181}Hf are used. In comparison with the previous method this method gives an increase in precision, especially in the area of low hafnium concentrations. (tr-auth)

32119 DETERMINATION OF HAFNIUM CONCENTRATION IN ZIRCONIUM. I. Onosov, A. I.; Perovskii, A. P. Radiokhimiya, 9: 269-71(1967). (In Russian).

A neutron activation method for analysis of binary mixtures of Zr–Hf, using the difference of the value of the internal conversion coefficient of the γ transitions ^{181}Ta and ^{95}Nb, decay products of ^{181}Hf and ^{95}Zr, is described. (tr-auth)

32120 QUANTITATIVE ANALYSIS OF THE TWO-COMPONENT MIXTURE OF RADIONUCLIDES. Piskunov, L. I. Radiokhimiya, 9: 266-8(1967). (In Russian).

Formulas for calculation of the activity of radionuclides in two-component mixtures from their radioactive decay were given. The graphic determination of the activity and evaluation of the content of radionuclides in two-component mixtures were proposed. An example of the determination of ^{90}Y from the decay of mixtures of the radioactive isotopes ^{90}Y + ^{91}Y was shown. (tr-auth)

32121 DETERMINATION OF PALLADIUM, OSMIUM, IRIDIUM, AND PLATINUM IN ROCKS BY NEUTRON-ACTIVATION ANALYSIS. Maleszewska, Hanna (Inst. of Nuclear Research, Warsaw). Chem. Anal. (Warsaw), 12: 281-91(1967). (In Polish).

A method is described for the determination of microquantities of palladium, osmium, platinum, and iridium in rocks. The samples were irradiated in a thermal neutron flux of 3.6×10^{11} neutrons/cm^2/sec in the EWA reactor for 20 hr. Radiochemical separation using carriers was carried out in order to isolate the activities induced. Palladium, platinum, and iridium were separated from samples by precipitation and extraction. Palladium was finally isolated as dimethylglyoximate and platinum and iridium as free metals. Osmium was separated from the samples by distillation of its volatile tetraoxide, which was subsequently absorbed in 6N hydrochloric acid saturated with sulfur dioxide. The sensitivity of the method for palladium was 10^{-7} g, for osmium was 10^{-6} g, for iridium was 10^{-7} g, and for platinum was 5×10^{-6} g. (auth)

32122 SIMPLIFIED METHOD OF URINARY URANIUM ANALYSIS FOR RADIATION PROTECTION MEASURES. Anzai, Ikuro; Maeda, Kazuho (Tokyo Univ.). Nippon Genshiryoku Gakkaishi, 9: 321-6(June 1967). (In Japanese).

A method of urinary uranium analysis using a sodium fluoride pellet was developed. A predetermined volume of urine not previously subjected to any chemical treatment was dropped on a pellet of sodium fluoride (NaF) powder, and after drying, was sintered in an electric furnace for about 10 min at a temperature of 950°C. When the sintered pellet was exposed to ultraviolet light, it emitted fluorescence of a certain wavelength characteristic of uranium, and of intensity fairly well proportional in a wide range to the concentration of uranium in the sample urine. This method can be effectively used in practice for quantitative analysis of urinary uranium in radiation protection measures. (auth)

32123 DETERMINATION OF BORON CONTENT IN BOROSILICATE GLASSES BY NEUTRON TRANSMISSION. Ideno, Kazumi (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 9: 317-20(June 1967). (In Japanese).

Determination of the boron content in borosilicate glasses was successfully carried out by neutron transmission using the JRR-2 neutron crystal spectrometer. The boron content was calculated from the measured macroscopic neutron cross section of the glass plates. The principal sources of error in this method are the statistical error in the observed neutron transmission and ambiguity of the neutron absorption cross section of natural boron contained in the glasses. If more than 0.1% boron is contained in borosilicate glass, the boron content can be determined with an accuracy of a few percent. (auth)

32124 THE DETERMINATION OF ^{35}S IN ORGANIC COMPOUNDS BY GAS COUNTING AS HYDROGEN SULPHIDE. Mlinko, S.; Gacs, I. (Hungarian Academy of Sciences, Budapest). Int. J. Appl. Radiat. Isotop., 18: 457-63(July 1967).

A method for the gas-phase activity measurement of ^{35}S-labelled organic compounds is described. The compounds are destructively hydrogenated and the sulphur products of pyrolysis are quantitatively converted into hydrogen sulphide over a platinum catalyst. No vacuum apparatus is needed for the analysis, which is similar to a procedure used for ^{14}C and tritium. The hydrogen sulphide is frozen out at atmospheric pressure from the hydrogen carrier gas in a cooling trap connected to the counter tube. Following reduction of pressure, the hydrogen sulphide is allowed to expand and the counter is filled with methane up to atmospheric pressure. The analysis of a sample takes 20 to 25 min and a counting efficiency of 95 to 96% can be achieved. (auth)

32125 EFFECT OF ELECTROLYTES ON MOISTURE DETERMINATION BY NUCLEAR MAGNETIC RESONANCE. Saraf, D. N.; Fatt, I. (Univ. of California, Berkeley). Nature, 214: 1219-20(June 17, 1967).

NMR techniques are used to measure the liquid water content of solutions, emulsions, porous materials, biological materials, organic liquids, etc. The absorption is usually assumed to vary linearly with the number of protons present in the aqueous sample. The authors found, however, that the absorption is also influenced by the ionic electrical conductivity of the water in the sample. This effect was first observed when attempting to measure the liquid hydrocarbon content of a sandstone specimen that also contained D_2O. The absorption was larger than expected, and depended on the salt content of the D_2O. Experiments employing aqueous solutions of NaCl are described, which established the hypothesis that it was the presence of a conducting liquid in the sample that caused the increase. These findings are of importance in that a change in the ionic content of the water may be misinterpreted as a change in water content. (UK)

32126 SOLVENT EXTRACTION AND SPECTROPHOTOMETRIC DETERMINATION OF CESIUM ION WITH CHROMIUM COMPLEXES. Fujinaga, T.; Koyama, M.; Tochiyama, O. (Kyoto Univ.). J. Inorg. Nucl. Chem., 29: 1372-4(May 1967).

Studies are reported on the extraction of cesium and some other alkali metal ions from neutral aqueous solution into nitrobenzene or nitropropane with added tetrathiocyanatodianiline chromate (III) $[Cr(NCS)_4(NH_2C_6H_5)_2]^-$, followed by spectrophotometric determination of the cesium. The cesium salt of this complex, extracted into nitrobenzene, shows an absorption maximum at 555 mμ the absorbancy of which is proportional to the cesium ion concentration. Extraction efficiencies were determined using ^{137}Cs tracer. More than 95% of the Cs, at an initial concentration of 10^{-3}M, could be extracted with a single treatment. The extraction of carrier-free ^{137}Cs was also investigated in the presence of other alkali metal ions. It was found that in the presence of $<2 \times 10^{-3}$M of any other alkali metal ions, with 8×10^{-3}M of the chromium complex, the extraction could be performed quantitatively. Other analogous complexes were similarly examined as reagents for the Cs ion. (UK)

32127 DETERMINATION OF CHLORINE IN U. S. GEOLOGICAL SURVEY STANDARD ROCKS BY NEUTRON ACTIVATION ANALYSIS. Johansen, O.; Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). Geochim. Cosmochim. Acta, 31: 1107-9(June 1967).

The chlorine content in eight U. S. Geological Survey standard rocks was determined by neutron activation analysis. The results are within the range 9.4 to 431 ppM, and the precision from duplicate determinations is about ±3%. (auth)

32128 PRESENT STATE OF COMPLEXOMETRY. IV. DETERMINATION OF RARE EARTHS. Pribil, Rudolf (Heyrovskii Polarographic Inst., Prague). Talanta, 14: 619-27(June 1967).

A review of the visual complexometric determination of the rare earths, with various volumetric reagents is presented. Attention is paid to the problems of interferences in the determinations. Methods for the determination of Th, Sc and some rare earths in mixtures are described in detail. Recent developments and further possibilities in this field are discussed. (auth)

32129 EXTRACTIVE PHOTOMETRIC DETERMINATION OF LANTHANIDES AND YTTRIUM WITH CHLOROPHOSPHONAZO DAL. Budesinsky, Bretislav; Menclova, Blanka (Nuclear Research Inst., Prague). Talanta, 14: 688-90(June 1967).

An extraction photometric method using chlorophosphonazo DAL, i.e. the dianilide of 3,6-bis(p-chloro-o-phosphonophenylazo) chromotropic acid, in butanol is proposed for the determination of trace amounts of Y and lanthanides in U, Co, Cu, Fe, Zn, Cd, and mineral ores. (auth)

32130 DETERMINATION OF ENERGY AND INTENSITY OF COMPLEX PHOTOPEAKS. Mundschenk, H. (Univ., Mainz). Int. J. Appl. Radiat. Isotop., 18: 365-81(1967). (In German).

Some suitable methods to decompose photopeaks in gamma-spectrometric determination of radioisotopes, even under unfavorable conditions, are described. The determination of the center of the overlapping peaks is achieved by differentiating the measured and corrected spectrum in the normal or logarithmic form. This method for calculating the peak area takes into account the fact that all photopeaks in a wide energy and intensity range can be described exactly by two empirical functions, which are normalized with respect to the fractional peak height. For analyzing some typical examples of overlapping photopeaks, the procedures were modified in a suitable manner. The calculations performed demonstrated the applicability, sensitivity, and accuracy of the methods presented. (auth) (UK)

32131 TIN: ITS ISOTOPIC AND ELEMENTAL ABUNDANCE. de Laeter, J. R.; Jeffery, P. M. (Univ. of Western Australia, Nedlands). Geochim. Cosmochim. Acta, 31: 969-85(June 1967).

The isotopic composition of tin in a variety of meteoritic and terrestrial samples was studied. No evidence of significant variations resulting from inhomogeneities in Galactic or Solar System nucleosynthetic processes was found. The elemental abundance of tin in fourteen iron, one stony iron, and four chondritic meteorites was determined using the method of isotope dilution. The tin concentration was found to range from <0.1 to 7.6 ppM, confirming earlier abundance data relating to tin in meteorites. The precision of isotopic abundance measurements by solid source mass spectrometry was adversely affected by mass fractionation. For polyisotopic elements, such as tin, this effect can be partly overcome by using the sample itself as an internal standard. (auth)

32132 K/Rb RATIOS IN AUSTRALITES. Taylor, S. R. (Australian National Univ., Canberra); Erlank, A. J.; Gurney, J. J. Geochim. Cosmochim. Acta, 31: 953-60(June 1967).

New isotope dilution determinations of Rb in seven australites, which cover the range in composition of the group, were 15 to 20% higher than previous determinations by Taylor (1960, 1962) and Taylor and Sachs (1961, 1964), and agreed with those of Pinson et al. (1965). The average Rb in australites increased from 84 to 100 ppM and the average K/Rb ratio decreased from 225 to 186 (range 173 to 194). A strong positive correlation exists between K and Rb in australites (r = +0.990). An inverse correlation apparently exists between K/Rb and Rb (+K). The causes of low K/Rb ratios are considered. The variation in K/Rb ratios between different tektite groups is considered due to variations in parent material. (auth)

32133 SPECTROGRAPHIC DETERMINATION OF ALLOYING ELEMENTS IN ZIRCALOY-2 BY THE POINT-TO-PLANE LOW VOLTAGE SPARK TECHNIQUE. IV. SPECTROCHEMICAL ANALYSIS OF ZIRCONIUM AND ITS ALLOY. Mizuno, Tomomi; Matsumura, Tetsuo (Kobe Steel Ltd., Japan). Nippon Kinzoku Gakkaishi, 31: 227-32(1967). (In Japanese).

A spectrographic method was developed for the simultaneous determination of chromium, iron, nickel, and tin in Zircaloy-2. Analyses were made on samples in the form of solid, machined specimens 30 mm in diameter. Spectra were excited with a low voltage spark (multisource type) in argon atmosphere and recorded on a photographic plate with the Ebert mounting spectrograph. Zirconium was used as the internal standard. Various kinds of counter electrodes, such as graphite, silver, copper, aluminium, zinc, tungsten and iron, were investigated. Precision of the method was 3 to 7%. (auth)

32134 AKTIVATSIONNYI ANALIZ GORNYKH PORODI DRUGIKH OB'EKTOV. (Activation Analysis of Rocks and Other Objects). Khaidarov, A. A. (ed.). Tashkent, Izdatel'stvo Fan Uzbekskoi SSR, 1967. 192p.

Neutron-activation methods for determining various elements in minerals, ores, and deposits are discussed. Applications of the method for gold, copper, bismuth, hafnium, and other elements in ore specimens using scintillation spectra are described as well as the method for determining microelements in ashes of plants and biological tissues. (R.V.J.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 32125, 32476, 32840, 32859, and 33292.

32135 (AWRE-O-27/67) THE PHYSICAL STABILITY OF METAL TRITIDES. LITHIUM TRITIDE AND DEUTEROTRITIDES. Jones, P. M. S. (Atomic Weapons Research Establishment, Aldermaston (England)). June 1967. 46p. Dep. CFSTI. UK 7s.0d.

The gas evolution from lithium tritide and deuterotritide, together with their expansion, has been measured at 20, 60, and 100°C for a period of years. The results are interpreted in terms of helium bubble formation and a reversible production of hydrogen atoms. The hydrogen release is inhibited by lithium atoms and diffusion of helium and lithium play a dominant role in the gas release from the solid. (auth)

32136 (BNL-11522) ELECTRONIC MECHANISMS IN SOLID STATE PHOTOLYSIS. Levy, P. W.; Herley, P. J. (Brookhaven National Lab., Upton, N. Y.). [1967]. 23p. (CONF-670625-1). Dep. CFSTI.

From International Symposium on Kinetics of Reactions in Ionic Systems, Alfred, N. Y.

When some crystalline solids are photolytically decomposed several of the effects that occur indicate that electrons, holes, or excitons are involved in the reaction. The kinetics of many of these reactions appear to be approximately, but not precisely, second order. The nature of these effects suggests that the photolytic reactions are essentially electronic and that they occur at certain crystal sites or defects when these become doubly excited. The results obtained when $NaBrO_3$ was photolytically decomposed, particularly the dependence of the equilibrium rate on light intensity, suggest that the doubly excited sites may also generate additional sites. Furthermore, the data indicate that some decomposition sites may be generated from precursors that are expended during the photolytic reaction. Using these concepts, a phenomenological theory was developed, which is consistent with current results. In particular, it indicates that the photolytic rate vs. time curves should be resolvable into one constant and two exponential components. Also it predicts, in agreement with the data, that the exponential component attributable to the sites generated from precursors should be reduced, even to the point of disappearing, when the material is subjected to ionizing radiation prior to photolysis. (auth)

32137 (BNWL-SA-1154) DISSOLUTION OF THORIUM OXIDE. Phillips, J. F. Jr.; Huber, H. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1, 1967. Contract AT(45-1)-1830. 17p. (CONF-670720-3). Dep. CFSTI.

From Northwest Regional Meeting of the American Chemical Society, Richland, Wash.

A least squares quadratic equation was developed for predicting relative thorium oxide dissolution rates as a function of nitric acid, thorium nitrate, aluminum nitrate, and hydrofluoric acid concentrations. Dissolution rates were found to be directly proportional to nitric acid concentration and inversely proportional to aluminum nitrate and thorium nitrate concentration. In the absence of aluminum and thorium nitrates, the dissolution rate passed through a maximum at 0.055M hydrogen fluoride. (auth))

32138 (CEA-BIB-87) PROPRIETES PHYSIQUES MOLECULAIRES DES ISOTOPES DE L'HYDROGENE ET DE LEURS COMBINAISONS ISOTOPIQUES. ETUDE BIBLIOGRAPHIQUE. (Molecular Physical Properties of the Hydrogen Isotopes and of Their Isotopic Combinations. Bibliographical Compilation). Guizouarn, Louis (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1967. 55p. (In French). Dep.

All the experimental data found in the literature published during the last 30 years concerning the physical properties of deuterium and tritium in liquid, solid, and gaseous phases are presented. Bibliographical research stopped in April 1965. (auth)

32139 (COO-676-1) THE DEVELOPMENT AND TESTING OF ORGANIC REAGENTS FOR USE IN INORGANIC ANALYSIS. Progress Report, September 1, 1966-May 15, 1967. Freiser, Henry (Arizona Univ., Tucson. Dept. of Chemistry). Apr. 27, 1967. Contract AT(11-1)-676. 27p. Dep. CFSTI.

Developments are reported for studies on: adduct formation in solvent extraction of chelates; mixed ligand formation in chelate extraction; calorimetric determination of enthalpies of chelate formation; ion pair extraction involving metallochromic indicators; and sulfur-containing ligands. Supporting data for the various studies are appended. (P.C.H.)

32140 (COO-1140-157) THE CHEMICAL AND THERMODYNAMIC PROPERTIES OF VANADIUM BORIDES AND RELATED SYSTEMS. PART I. THE VANADIUM-BORON SYSTEM. PART II. THE VANADIUM-BORON-NITROGEN SYSTEM. PART III. CHEMICAL TRANSPORT STUDIES INVOLVING VANADIUM. Spear II, Karl E. (Kansas Univ., Lawrence. Dept. of Chemistry). Apr. 17, 1967. Contract AT(11-1)-1140. 458p. Dep. CFSTI.

Thesis.

The high temperature chemistry of vanadium, especially the

vanadium borides, is reported in three parts. The first part relates to the vanadium–boron system and reports studies of phase relationships, structures, vaporization behavior, and thermodynamic properties. The second part relates to the vanadium–boron–nitrogen system and presents equilibrium and thermodynamic information. The third part relates to chemical transport studies involving both elemental and combined vanadium and reports phase and thermodynamic information obtained from these studies. (92 references). (P.C.H.)

32141 (K–1690) THERMISTORIZED EBULLIOMETRY SYSTEM FOR DETERMINING MOLECULAR WEIGHTS OF FLUOROCARBONS. Rivers, R. D.; Gentry, W. O.; Kienberger, C. A. (Oak Ridge Gaseous Diffusion Plant, Tenn.). July 17, 1967. Contract W-7405-eng-26. 21p. Dep. CFSTI.

A thermistorized ebulliometry system was devised, constructed, and calibrated for making molecular weight measurements of fluorocarbon compounds, using Freon-113 as the solvent. The system consisted of a glass probe containing thermistors encased in epoxy resin, a commercially fabricated vacuum-jacketed ebulliometer, a bridge circuit, and an electronic galvanometer. The ebulliometry system was thermally insulated with plastic foam and shielded with an electrically grounded aluminum case. The thermal noise background of the new system limited the temperature readability to ±0.00035°C, approximately one-tenth that of a former thermometer ebulliometry system. This decrease in noise background, when applied to molecular weight measurements, represents a corresponding improvement in precision of about tenfold over previous molecular weight measurements in the range of 1000 to 1200. The absolute standard deviation of a single molecular weight measurement in this range is ±8 mol. wt units for the new system. (auth)

32142 (ORNL–4129) SIGNIFICANCE OF CHARCOAL IGNITION TEMPERATURES. Davis, R. J. (Oak Ridge National Lab., Tenn.). July 1967. Contract W-7405-eng-26. 21p. Dep. CFSTI.

Ignition temperature is defined in terms of a simple theoretical model, resulting in a working equation that relates ignition temperature to several parameters. These include: the charcoal activity (the effect of promoters, inhibitors and surface area), oxygen activity (air velocity, oxygen concentration), the stoichiometry of the chemical reaction and the activation energy of the rate-determining step of the mechanism. Use of the working equation is demonstrated. Effects of surface area, ash content, and air velocity are correlated with the working equation as the basis. (auth)

32143 (ORNL–TM–1884) CHEMICAL SAFETY. Keilholtz, G. W. (Oak Ridge National Lab., Tenn.). June 6, 1967. Contract W-7405-eng-26. 46p. Dep. CFSTI.

Chemicals in any form can be safely stored and used if their physical and chemical properties are fully understood and the necessary precautions, including the use of proper safeguards and protective equipment, are observed. Physical and chemical explosions are discussed with emphasis on ether peroxides and hydrogen. The hazards and toxic properties of certain metals and organic compounds are briefly described. The basic responsibility for safety remains with the individual and his supervision. They should fully understand the material properties and the precautions required in any set of chemical operations. (auth)

32144 (SC–DC–67–1831) NOVEL FERROCENE–URETHANE FOAM. Fawcett, Newton C.; Anderson, D. Richard; Cassidy, Patrick E. (Sandia Corp., Albuquerque, N. Mex.). June 1967. Contract AT(29-1)-789. 4p. (CONF-670904–2). Dep. CFSTI.

From 154th National Meeting of the American Chemical Society, Chicago, Ill.

Preparation for a rigid urethane foam that includes 1,1′-bis(α-hydroxyethyl) ferrocene as part of the hydroxyl component is reported. Physical properties of the foam are similar to those of an ϵ-caprolactone-pentaerithritol polyester–PAPI polymethylene polyphenylisocyanate foam. (auth)

32145 (SC–RR–67–316) A STRUCTURE–PROPERTY STUDY OF THERMOSETTING RESIN SYSTEMS. I. PREPARATION AND POLYMERIZATION OF ALKENYL-SUBSTITUTED IMIDES AND THEIR EPOXY DERIVATIVES. Anderson, D. R.; Rogers, C. J. (Sandia Corp., Albuquerque, N. Mex.). June 1967. Contract AT(29-1)-789. 17p. Dep. CFSTI.

The initial phase of the structure/property study (i.e., developing a characterizable thermosetting polymer system with a capability of synthetic variation) was completed. Several N-alkyl- and alkenyl-substituted imides and their epoxy derivatives were prepared and polymerized. (auth)

32146 (TID–23874) FINAL TECHNICAL REPORT [ON DIFFUSION AND ELECTRICAL CONDUCTIVITY OF ALKALI HALIDES]. Schamp, Homer W. Jr. (Maryland Univ., College Park). [1967]. Contract AT(40-1)-2068. 158p. Dep. CFSTI.

Measurements of chloride ion diffusion in KCl were made in the pressure range between 7 and 17 kbars at three different temperatures: 685, 745, and 797°C. Isotherms for diffusion measurements at 685 and 745°C showed normal behavior with log D decreasing linearly with pressure. The activation volumes were computed to be 11.7 ± 0.7 cm^3/mole at 685°C and 11.8 ± 0.7 cm^3/mole at 745°C. The 797°C isotherm greatly differed from the other two. It is suggested that an increase in the diffusion coefficient in the vicinity of 17 kbars might be accounted for by the high pressure phase transition in KCl that occurred at 18 kbars. (P.C.H.)

32147 (TID–23908) THERMODYNAMICS OF ION EXCHANGE ON COLLOIDAL MATERIALS WITH APPLICATIONS TO SILICATE MINERALS. Final Report. Thomas, Henry C. (North Carolina Univ., Chapel Hill). Mar. 1967. Contract AT(40-1)-2130. 87p. Dep. CFSTI.

Thermodynamics of interfacial regions are discussed, including a review of some necessary parts of classical thermodynamics followed by a detailed development of the application to surface regions. Ion exchange on clay minerals is used to give illustrations of the use of the results. Examples of the great simplifications that must be made in the application of equilibrium data to flow through beds of ion exchangers are given to illustrate approximate applications to flowing systems. (P.C.H.)

32148 (UCRL–17395) EXCHANGE OF ENERGY BETWEEN TUNGSTEN AT HIGH TEMPERATURES AND GASES AT ROOM TEMPERATURE. Lim, Mahn Jick (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1967. Contract W-7405-eng-48. 98p. Dep. CFSTI.

Thesis.

The exchanges of energy between a tungsten filament and room temperature neon, nitrogen, argon, krypton, oxygen, nitric oxide, nitrous oxide, mixtures of neon with krypton, and mixtures of argon with oxygen were studied over a wide range of filament temperatures and gas pressures. For non-reactive gases, the thermal accommodation coefficient was found to be independent of gas pressures between 1×10^{-7} and 5×10^{-5} atm and to depend on filament temperatures in a complex manner in the temperature range from 700 to 2800°K. The general trends in temperature dependences of the thermal accommodation coefficients were similar for the noble gases and for nitrogen. The variations for these gases are believed to reflect primarily changes in the fraction of coverage of adsorbed surface impurities and in surface structures. All show maximum thermal accommodation coefficients near 2000°K. For oxygen, below 1500°K, the energy exchange phenomenon was very similar to those for non-reactive gases. In the temperature range from 1500 to 1800°K an exothermic energy exchange occurred that was nearly independent of gas pressure. Above 1900°K, where the exchange was again endothermic, the pressure dependence of the energy exchange became more pronounced as the solid temperature was further raised. At very low oxygen pressures, an abnormally high apparent energy exchange was observed presumably due to instantaneous carbon content change causing an electrical resistance change and due to large errors in the measurement of energy exchange at low pressures. For oxygen, nitric oxide, and nitrous oxide, the energy exchange at about 2600°K was high enough to support the conclusion that essentially all incident molecules react. The energy exchanges of mixtures of neon with krypton were essentially the arithmetic sums of the energy exchanges of the individual species at 2142°K. The same was found for argon–oxygen mixtures at 2528°K. At 1740 and 2200°K, departure from this simple addition rule was found especially for higher oxygen mole fractions. (auth)

32149 (UCRL–17561) NUCLEAR MAGNETIC RESONANCE RELAXATION OF ^{17}O IN AQUEOUS SOLUTIONS OF FERRIC ION. Judkins, Malcolm Robert (California Univ., Berkeley. Lawrence Radiation Lab.). May 1967. Contract W-7405-eng-48. 75p. Dep. CFSTI.

Thesis.

The ^{17}O NMR signal in aqueous solutions of ferric ion was studied as a function of temperature, frequency, and solution composition in order to separate the various effects arising from ferric ion and its hydrolyzed species. The principal species affecting the ^{17}O NMR width by water exchange were found to be Fe^{3+}, $FeOH^{2+}$, and $Fe_2(OH)_2^{4+}$. The ferric ion produces line broadening arising from exchange out of both a first and an outer coordination sphere. The first coordination sphere waters exchange slowly enough to be in the exchange controlled region. The outer coordination sphere exchange is rapid and the ^{17}O nuclear spin is probably relaxed by a combination of scalar coupling and $\Delta\omega$ mechanisms. The first and outer coordination sphere effects cannot be separated unequivocally and consequently only a range of values is reported for the exchange rates. It

appears that $FeOH^{2+}$ and $Fe_3(OH)_4^{5+}$ are in the relaxation controlled region for the water exchange. Only a lower limit for the exchange rate from the first coordination sphere is given. The relaxation seems to be a consequence of both scalar coupling and $\Delta\omega$ mechanisms. The species $Fe_3(OH)_4^{5+}$ does not contribute measurably to the line broadening, presumably because of a low magnetic moment. (auth)

32150 (IS-Trans-67) THE FUSIBILITY DIAGRAM OF THE KCl–$ThCl_4$ SYSTEM. Desyatnik, V. N.; Dubinin, V. A.; Nichkov, N. F.; Raspopin, S. P. Translated for Ames Lab., Iowa, from Izv. Vyssh. Ucheb Zaved., Tsvet. Met., 9: No. 4, 82-3(1966). 3p. Dep. CFSTI. JCL $1,10 fs, $0,80 mf.

The fusibility diagram of the KCl–$ThCl_4$ system was constructed on the basis of thermograms. In the KCl–$ThCl_4$ system there were two chemical compounds: K_2ThCl_6, melting incongruently at 617°, and $KThCl_5$, melting congruently at 457°. Two points of eutectic composition were found: 44 to 45 mole % $ThCl_4$ with a melting point of 376° and 56 to 58 mole % $ThCl_4$ with a melting point of 416°C. However, thermal analysis data do not confirm the existence of the compounds K_3ThCl_7 and a eutectic point, corresponding to the composition 11.7 mole % $ThCl_4$. (P.C.H.)

32151 DEUTERON MAGNETIC RESONANCE STUDY OF THE O–D—O AND ND_3 BONDS IN FERROELECTRIC TRIGLYCINE SULPHATE. Blinc, R.; Pintar, M.; Zupancic, I. (Nuclear Inst. J. Stefan, Yugoslavia, Univ. of Ljubljana, Yugoslavia). J. Phys. Chem. Solids, 28: 405-12(Mar. 1967).

The O–D- -O and ND_3 deuteron quadrupole coupling tensors of deuterated triglycine sulphate (TGS) were determined both above and below the ferroelectric Curie point T_c. The most significant effect of the ferroelectric phase transition is, besides the large, gradual displacement of the ND_3 group of glycine I away from the mirror plane, the onset of chemical nonequivalence of glycine III and the zwitter ion glycine II, accompanied by a rotation of the O–D- -O deuteron quadrupole coupling tensor along the direction of the O(III)–D- -O(II) bond, which seems to indicate an ordering of the deuterons in the short H-bonds. The ferroelectric phase transition can thus perhaps be best described as a combination of an order-disorder transition in the O(III)–D- - -O(II) hydrogens and glycines II and III with a displacive transition in glycines I. (auth)

32152 MASS SPECTROMETRIC STUDIES OF THE VAPORIZATION OF REFRACTORY COMPOUNDS. Drowart, J.; Pattoret, A.; Smoes, S. (Univ. Libre, Brussels). Proc. Brit. Ceramic Soc., No. 8, 67-89(June 1967).

A modified Knudsen-cell assembly for use in mass spectrometric studies of the thermodynamics of vaporization of refractory substances is described. The assembly can be positioned from the outside of the instrument, permitting direct comparison of pressures in different systems located in adjacent twin cells or of free surface vaporization and effusion under equilibrium conditions. The assembly makes possible determinations of absolute pressure by condensation of a known fraction of the effusing vapour. Thermochemical applications of the mass spectrometer–Knudsen cell technique for the study of refractory compounds are reviewed. Dissociation energies of the gaseous oxides BO, ScO, YO, LaO, VO, CeO, UO, UO_2, and UO_3 and of the gaseous sulphides GeS, ScS, VS, CrS, FeS, MnS, CoS, NiS, CuS, YS, LaS, and CeS derived from exchange reactions are reported and where possible compared with literature data. Partial pressures for U, UO, and UO_2 are given for the U–UO_2 two-phase system between 1700 and 2350°K, and at 2250°K throughout the $UO_{1.85}$–$UO_{2.0}$ homogeneity range. The congruently vaporizing composition was determined to be $UO_{1.987}$ $(+0.006 - 0.010)$. (auth) (UK)

32153 REACTION OF HYDROGEN WITH GRAPHITE. Palmer, D. J. (British Petroleum Co., Sunbury-on-Thames, Eng.). Nature (London), 215: 388-9(July 22, 1967).

Experiments are reported in which graphite was mechanically ground in the presence of hydrogen and nitrogen. The gases were taken up by the graphite during the comminution process. It was concluded that the absorption is due to chemical reaction, for the following reasons. Direct adsorption by the fresh graphite surface produced did not wholly account for the uptake, since the uptake was greater than when the graphite was first ground in vacuo and then placed in contact with the gas. Also, it is reasoned that neither H_2 nor N_2 reacts with the active (free radical) sites produced by fracture of the graphite planes, since it was shown that these are most readily neutralized by subsequent treatment with oxygen and the amount of oxygen absorbed depends only on the fresh surface produced, irrespective of whether the graphite is initially ground in hydrogen, nitrogen, or in vacuo. Also, in the case of nitrogen, there was a strong smell resembling HCN. It is suggested that reactions occur due to subjection to instantaneous high temperatures, generated by friction between the steel grinding balls. Because of the rapid dissipation of heat from the frictional contacts, however, this high temperature is extremely localized. (UK)

32154 ELECTROCHEMICAL REDUCTION OF UO_2^{2+}–Me_2CO_3–H_2O_2 SOLUTIONS. I. POLAROGRAPHIC AND COULOMETRIC STUDY IN 1M Na_2CO_3. Zutic, V.; Branica, M. (Ruder Boskovic Inst., Zagreb). J. Polarogr. Soc., 13: 9-16(1967).

Reduction of uranyl peroxodicarbonate in 1M Na_2CO_3 solutions was studied by means of polarography and controlled-potential electrolyses at mercury electrodes. Only one irreversible reduction wave, with the half-wave potential at –1.15 V vs S.C.E., was observed. The overall electron change was found to equal 3, and the final product of the electrode reaction was identified as the uranium(V) carbonate complex. The interaction of uranium(V) and uranyl peroxodicarbonate to form uranyl tricarbonate was studied on the macro-scale, and a mechanism for the reduction of uranyl tricarbonate and uranyl peroxodicarbonate mixtures at the dropping mercury electrode is proposed, as well as for the simultaneous reduction of hydrogen peroxide and uranyl peroxodicarbonate. (auth)

32155 RADIATION-INDUCED POLYMERIZATION BY FREE IONS. PART 2. ELECTRICAL CONDUCTIVITY MEASUREMENTS. Hayashi, Kanae; Yamazawa, Yuzo; Takagaki, Torao; Williams, Ffrancon; Hayashi, Koichiro; Okamura, Seizo (Japanese Association for Radiation Research on Polymers, Osaka). Trans. Faraday Soc., 63: 1489-1500(June 1967).

The radioinduced specific electrical conductivities σ of rigorously dried cyclohexane, styrene, α-methylstyrene, and isobutyl vinyl ether were measured as a function of dose rate I. A dependence $\sigma \propto I^n$ was observed with n between 0.50 and 0.59, depending upon the system. It was confirmed that the absolute measurements of σ for cyclohexane are consistent with G(free ions) $\approx$0.1, on the basis of reasonable values for the ionic mobilities. The mean lifetime τ (sec) of the ions in the stationary state is obtained directly from σ ($ohm^{-1}cm^{-1}$) by means of the relation $1/\tau = 3.6 \times 10^{12}\, \pi\sigma/\epsilon$, where ϵ is the dielectric constant; τ is about 50 msec at $I = 10^{15}$ eV cm^{-3} sec^{-1} for the monomer systems. At the same dose rate, the σ values for styrene and α-methylstyrene are lower than for cyclohexane by a factor of about 2. Results suggest that some charge carriers in the monomers have mobilities comparable to those in cyclohexane. The radioinduced conductivities of the hydrocarbon monomers are not appreciably affected by the addition of ethanol and ammonia, but are reduced by water. Some possible reasons for this behavior are examined. (auth)

32156 MIXED CONDUCTION IN $Zr_{0.85}Ca_{0.15}O_{1.85}$ AND $Th_{0.85}Y_{0.15}O_{1.925}$ SOLID ELECTROLYTES. Patterson, John W.; Bogren, E. C.; Rapp, Robert A. (Ohio State Univ., Columbus). Contract AT(11-1)-1440. J. Electrochem. Soc., 114: 752-8 (July 1967). (TID-23722).

The dc polarization technique according to Wagner [C. Wagner, Z. Elektrochem., 60, 4(1956); 63, 1027(1959)] was applied at elevated temperatures for the determination of $\sigma_\ominus$, partial excess electron conductivity, and $\sigma_\oplus$, partial positive hole conductivity, in the $Zr_{0.85}Ca_{0.15}O_{1.85}$ and $Th_{0.85}Y_{0.15}O_{1.925}$ electrolytes over a range of oxygen activity and temperature. The applicability of the technique and an improved method for data analysis are demonstrated. Experimental difficulties and limitations are discussed. The total conductivity of $Zr_{0.85}Ca_{0.15}O_{1.85}$ was determined over a range of oxygen activity and temperature. (auth)

32157 RECENT IMPROVEMENTS IN BENZENE CHEMISTRY FOR RADIOCARBON DATING. Noakes, John; Kim, Stephen; Akers, Lawrence (Oak Ridge Associated Universities, Tenn.). Geochim. Cosmochim. Acta, 31: 1094-6(June 1967).

Benzene radiocarbon dating is discussed in view of recent improved chemistry. A high yield benzene catalyst is described which eliminates concern for carbon isotope fractionation, benzene purity, and extensive sample preparation time. (auth)

32158 INFRARED ABSORPTION SPECTRA OF CUBIC PYROPHOSPHATES AND PYROARSENATES OF TETRAVALENT ELEMENTS, $X^{IV}P_2O_7$ AND $X^{IV}As_2O_7$. Hubin, R.; Tarte, P. (Univ., Liege). Spectrochim. Acta, 23A: 1815-29(June 1967). (In French).

The ir absorption spectra of a series of cubic pyrophosphates $X^{IV}P_2O_7$ (X = Si, Sn, Pb, Ti, Zr, Hf, U) and of a few corresponding pyroarsenates and pyrovanadates were studied in the 1300 to 250 cm^{-1} region. The spectra were consistent with a D_{3d} symmetry of the P_2O_7 group (linear P–O–P bridge) and most of the bands were assigned, either to the different vibrational modes of the P_2O_7 (or As_2O_7 or V_2O_7) anion, or to the stretching frequency of the $X^{IV}O_6$ octahedron (metal-oxygen vibration). The vibrational frequencies of the P_2O_7 anion depend on the ionic radius of the cation, but the observed relationships are drastically different according to whether the cations of the principal (Si, Sn, Pb) or of the secondary

(Ti, Zr, Hf) family are considered. Some of the observed relationships exhibited a quite unexpected upward trend, some P_2O_7 vibrational frequencies being higher for higher ionic radii. (auth)

32159 REDUCTION OF ORTHORHOMBIC MODIFICATION OF URANIUM TRIOXIDE BY METHANE. Vlasov, V. G.; Semavin, Yu. N. Zh. Prikl. Khim., 40: 1210-15(June 1967). (In Russian).

Experiments with γ-UO_3 reduction by methane at 450 to 700°C and gas-reducing agent pressure of 10 to 6000 mm Hg showed that the magnitude of the apparent activation energy as a function of reduction ratio varied from 19.7 to 28.5 kcal/mole. The rate of reduction as a function of methane pressure is expressed by the equation: $V = k \cdot P_{CH_4}^{1}{}^{0.1}$. The x-ray analysis indicated graduated and irregular zonal methane reduction of γ-UO_3. (R.V.J.)

32160 SPECTRA OF SILICON HYDRIDE AND SILICON DEUTERIDE. Klynning, L.; Lindgren, B. (Univ. of Stockholm). Ark. Fys., 33: 73-91(1967).

Using a King furnace the absorption spectra of the $^1\Delta - ^1\pi$ transition in SiH and SiD were generated and photographed with an eleven-meter concave grating spectrograph. Computer methods were used to determine term values and to fit energy expressions to these. Special attention was given to the spin-orbit coupling constants, which were found to vary with internuclear distance according to theory for the $^1\pi$ states, whereas for the $^1\Delta$ states no definite answer was obtained. (auth)

32161 DECARBOXYLATION OF SUBSTITUTED 4-AMINOBENZOIC ACIDS IN ACIDIC AQUEOUS SOLUTION. Los, J. M.; Rekker, R. F.; Tonsbeek, C. H. T. (Free Univ., Amsterdam). Rec. Trav. Chim., 86: 622-40(June 1967).

Rates of decarboxylation were determined for the following substituted 4-aminobenzoic acids 2-H−, 2-CH_3−, 2-Cl−, 2-Br−, 2-NO_2−, 2-OH−, 2-OCH_3−, 3-Br−, 2,6-$(CH_3)_2$−, 2,6-$(C_2H_5)_2$−, 2,6-Cl_2− and 2,6-Br_2− in aqueous hydrochloric acid solution (pH ranging from about 0 to about 2), at 50°C and an ionic strength of 0.1 (except for the lowest pH values). Analysis of the data in terms of a second-order mechanism involves predominantly the species neutral ampholyte (not zwitterion) and hydronium ion for the range $0 < pH < 2$. A general rate expression was derived with (neutral) ampholyte, anion decarboxylation, and hydronium-ion inhibition at lower pH. Essential to the mechanism is that the σ-complex formed by addition of a proton at the $C_{(1)}$ position of the neutral acid could not decarboxylate unless it first ionized into the corresponding anion (loss of the carboxyl proton). The formation of the σ-complex was not necessarily rate determining. The reaction mechanism can explain not only all relevant facts concerning the acids investigated but also the data offered by the literature on substituted benzoic acids, in particular all available data on the ^{13}C-carboxyl isotope effect and the (H_2O, D_2O) solvent isotope effect. (auth)

32162 INVESTIGATION OF HIGH TEMPERATURE OXIDATION OF ZIRCONIUM DIBORIDE. Voitovich, R. F.; Pugach, E. A.; Men'shikova, L. A. Porosh. Met., Akad. Nauk Ukr. SSR, No. 6, 44-8(June 1967). (In Russian).

The kinetics of zirconium diboride oxidation in the range of temperatures 300 to 1200° were studied, and an x-ray investigation of the formed scale layer was carried out. On the basis of comparison of the kinetics, x-ray, and thermodynamic data suggestions are made on the probable oxidation mechanism of ZrB_2. (auth)

32163 ISOTOPE EFFECTS IN THE DECARBOXYLATION OF 1-^{14}C-DICARBOXYLIC ACIDS STUDIED BY MEANS OF THE SCHMIDT REACTION. Rabinowitz, Joseph L.; Chase, Grafton D.; Kaliner, Lois F. (Univ. of Pennsylvania, Philadelphia, Philadelphia Coll. of Pharmacy and Science). Anal. Biochem., 19: 578-83(June 1967).

The isotope effect of 1-^{14}C-dicarboxylic acids during decarboxylation by the use of the Schmidt reaction was determined for malonic, succinic, glutaric, adipic, pimelic, suberic, azelaic, and sebacic acids. Results indicated a kinetic predilection for the loss of the ^{12}C-carboxyl group over the ^{14}C one. The observed isotope effects were in the range of 3 to 15%. The rate-determining step in the Schmidt reaction appeared to be a break of the C−C bond between the CO and adjacent methylene carbon during the Lossen rearrangement. Results suggest small but statistically significant isotope effect differences due to increased chain length and in grouping of odd- versus even-chain dicarboxylic acids. (auth)

32164 KINETICS OF THE REACTION BETWEEN PLUTONIUM(III) AND XENON TRIOXIDE. Cleveland, J. M. (Dow Chemical Co., Golden, Colo.). Inorg. Chem., 6: 1302-5(July 1967).

The kinetics of the reaction between Pu(III) and XeO_3, according to the equation $6Pu(III) + XeO_3 + 6H^+ \rightarrow 6Pu(IV) + Xe + 3H_2O$, were studied in perchlorate media by following the rate of disappearance of Pu(III) spectrophotometrically at 600 mμ. The rate law for the reaction is: $-d[Pu(III)]/dt = k[Pu(III)][XeO_3]$. The reaction rate was independent of acidity in the 0.5 to 2M range. From the variation of the reaction rate with temperature, the following thermodynamic quantities of activation at 25°C were calculated: $\Delta H^{\ddagger} = 15.3 \pm 2.1$ kcal/mole; $\Delta F^{\ddagger} = 20.2 \pm 0.1$ kcal/mole; $\Delta S^{\ddagger} = -16.0 \pm 6.9$ eu. The mechanism of the reaction appeared to involve either successive one-electron changes or a two-electron change to form a Pu(V) species other than PuO_2^+, which then reacts with Pu(III) to form Pu(IV). (auth)

32165 URANIUM(IV) SUCCINATES AND TARTRATE. Satapathy, K. C. (M.P.C. Coll., Baripada, India); Sahoo, B. Curr. Sci. (India), 36: 320(June 20, 1967).

The photochemical preparation of U(IV) succinate and tartrate having the formula $U_2O(C_4H_4O_4)_3$ and $U_2O(C_4H_4O_6)_3 \cdot 5H_2O$ is reported. The analysis of the compounds indicated both the ionic species UO^{2+} and U^{4+} present in the same compound. An oxysuccinate, $UO(C_4H_4O_4) \cdot 3H_2O$ was also prepared in the same manner. (B.L.M.)

32166 INFRARED SPECTRA OF THE PERTECHNETATES AND FERRHENATES OF TETRABUTYLAMMONIUM AND TETRAPHENYLARSONIUM: AND FACTOR GROUP ANALYSIS OF THE OPTICAL VIBRATIONS OF $KTcO_4$ IN THE INFRARED AND RAMAN SPECTRA. Mueller, A.; Rittner, W. (Univ. of Goettingen, Ger.). Spectrochim. Acta, 23A: 1831-7(June 1967). (In German).

The infrared absorption spectra of tetrabutylammonium pertechnetate and perrhenate and tetraphenylarsonium pertechnetate and perrhenate are reported. The internal vibrations of the TcO_4^- and ReO_4^- anions are assigned and discussed. The preparation of the crystalline tetrabutylammonium salts is described. The infrared spectrum of $KTcO_4$ was also measured and assigned according to the factor group C_{4h}. The Raman spectrum of $KTcO_4$ could also be assigned according to the factor group C_{4h}. (auth)

32167 PHOSPHATE OF CALCIUM AND URANIUM (IV): PREPARATION AND CRYSTALLOGRAPHIC CHARACTERIZATION. La Ginestra, Aldo; Variali, Galliano; Valigi, Mario (CNEN, Rome). Gazz. Chim. Ital., 95: 1096-9(Oct. 1965). (In Italian).

A description is given of the preparation and properties of the compound $CaU(PO_4)_2$, with a monazite-like structure resembling that of the known $CaTh(PO_4)_2$. The compound $CaU(PO_4)_2$ is monoclinic, with the following lattice constants: $a_0 = 7.292$ (±0.005); $b_0 = 6.452$ (±0.004), and $c_0 = 6.417$ (±0.004) Å; and $\beta = 101°38'$. Preparation of the compound was carried out by first preparing the Ca and U phosphates salts separately. After filtration and partial dessication of the 2 phosphates, the precipitates were mixed in 1:1 proportions of Ca and U(IV), and homogenized by shaking in alcohol for several hours. The alcohol was then evaporated and the mixture was heated in a stream of nitrogen for 12 hr at 950°C. Analysis of the calcined product revealed 11.70% CaO, 57.80% UO_2, and 30.40% P_2O_5 close to the expected values for $CaU(PO_4)_2$. The density determined pycnometrically was 5.25. (BBB)

32168 DETERMINATION OF THE PARTIAL PRESSURES OF OXYGEN IN EQUILIBRIUM WITH THE NONSTOICHIOMETRIC OXIDES OF THE SYSTEM U−O. I. CURVE OF THE ISOTHERM $P_{O_2}/(O/U)$ AT 1098°C. Kotlar, Alain; Gerdanian, Paul; Dode, Maurice (Faculte des Sciences, Orsay, France). J. Chim. Phys., 64: 862-8(May 1967). (In French).

The physicochemical equilibrium method between a gaseous phase and an oxide was applied with success to determine the partial pressures of oxygen in equilibrium with the nonstoichiometric oxides of the U-system at 1,098°C and for $2.21 < O/U < 2.63$. Well defined N_2-O_2 gaseous mixtures were used and the oxide evolution followed with an Ugine−Eyrad thermobalance. The UO_{2+x}, U_4O_{9-y}, and U_3O_{8-z} phases were pointed out and the two phase system limits defined: $UO_{2+x}-U_4O_{9-y}$ as $2.2210 < O/U < 2.2355$; $U_4O_{9-y}-U_3O_{8-z}$ as $2.2420 < O/U < 2.6180$. In the last range of composition, a succession of real and distinct oxygen pressure of equilibrium corresponded to the same composition of U. Two varieties of equilibrium were pointed out. An interpretation of the phenomena was proposed using the "small system" thermodynamic theory of Terrell L. Hill (Thermodynamics of Small Systems, Part I, pp. 114-131). (auth)

32169 SOME LAWS IN THE THERMODYNAMICS OF ISOTOPE EXCHANGE. Knyazev, D. A.; Bantysh, A. N.; Ivlev, A. A. (Inst. of Technology, Moscow). Kernenergie, 10: 113-21(Apr. 1967). (In Russian).

Using the Urey−Bradley−Simanouti potential function a large number of the β factors of isotope systems were determined in

good agreement with the experimental results. If some data formerly obtained are utilized, laws of thermodynamics may be derived from them, relating the magnitude of the β factors with both the position of the bond partners of the molecule in the periodic system and some intramolecular characteristics. Such systems are thermodynamically favorable for chemical exchange. (auth)

32170 STUDY OF THE SYSTEM UF_4–CaF_2. Nekrasova, N. P.; Oblomeev, E. N.; Golovanova, V. N.; Beznosikova, A. V. At. Energ. (USSR), 22: 293-7(Apr. 1967). (In Russian).

The UF_4–CaF_2 system was studied by utilization of thermographic, x-radiographic, and chemical analysis, on the basis of which the fusion diagram of UF_4–CaF_2 was constructed. UF_4 forms solid solutions with CaF_2 with a limiting solubility of the UF_4 of 32%. Increasing the concentration UF_4 in the solid solutions causes an increase of the period of the crystalline lattice from a = 5.45 to 5.56 Å. The system contains one chemical compound $CaUF_6$, which has a hexagonal crystalline lattice with the periods a = 3.997 and c = 7.103 Å and melts at a temperature of 1,008°C. The compound $CaUF_6$ is assigned to the diffraction class D_{3h} = 6/mmm; its elementary cell with the volume v = 98.27 Å^3 contains one formula unit with the x-radiographic density = 6.62 g/cm^3. (tr-auth)

32171 PHYSICOCHEMICAL STUDIES OF RADIUM COMPOUNDS. II. X RADIATION STUDIES OF RADIUM NITRATE. Vdovenko, V. M.; Dubasov, Yu. V. Radiokhimiya, 9: 201-6(1967). (In Russian).

An x-radiographic study was made of radium nitrate. It was shown that $Ra(NO_3)_2$ is isomorphous with $Pb(NO_3)_2$ and crystallizes in a cubic system with the space group Pa 3. The parameter of the elementary cell of radium nitrate is 8.284 ± 0.007 Å. The ionic radius of radium is 1.49 ± 0.01 Å, which is in good agreement with the previously known value 1.52 Å. The small increase of the ion radius of Ra^{2+} compared with the Ba^{2+} ion was explained by the presence in radium of a filled 4f electron shell. (tr-auth)

32172 COMPLEX FORMATION OF TETRAVALENT AMERICIUM, CURIUM, AND PROMETHIUM WITH METHYLPHOSPHINIC [SIC] ACID. Borisov, M. S.; Elesin, A. A.; Lebedev, I. A.; Piskunov, E. M.; Filimonov, V. T.; Yakovlev, G. N. Radiokhimiya, 9: 166-71(1967). (In Russian).

By means of potentiometric titration the dissociation constants of methylphosphonic acid were determined at constant ion strength μ = 0.2 in the temperature interval from 15 to 45°C. The sorption of tracer quantities of Am^{3+}, Cm^{3+}, and Pm^{3+} on cation exchange resins from solutions of methylphosphonic acid was investigated at different acid concentrations and pH 2 and 4. It was established that under the conditions given all three elements form complex ion states MHA^{2+}, characterized by the thermodynamic stability constants at μ = 0 and t = 25°C of 6.2×10^2 (Am), 6.6×10^2 (Cm), and 4.7×10^2 (Pm). (tr-auth)

32173 COMPLEX URANYL PEROXOFLUORIDE COMPOUNDS. Gurevich, A. M.; Susorova, N. A.; Kurbatov, V. V. Radiokhimiya, 9: 183-97(1967). (In Russian).

During investigation of the system $UO_2(NO_3)_2$–MF–H_2O_2–H_2O uranyl peroxofluoride complex compounds were synthesized with the following composition: $(NH_4)_2[(UO_2)_2(OO)F_4(H_2O)_2]$, $Na_2[(UO_2)_2(OO)F_6(H_2O)_2] \cdot 2H_2O$, $K_4[(UO_2)_3(OO)F_8]$, $Na_2[(UO_2)_3(OO)_2F_2(H_2O)_6] \cdot 2.5H_2O$, $K_2[(UO_2)_2(OO)_2F_2(H_2O)_4]$, $Na_2[(UO_2)_3(OO)_2F_2(H_2O)_2] \cdot 3H_2O$, $Na_4[(UO_2)_2(OO)_2F_4(H_2O)_4] \cdot 5H_2O$, $(NH_4)_4[(UO_2)_3(OO)_2F_4]$, and $(NH_4)_5[(UO_2)_2(OO)_2F_5(H_2O)]$. The optimum conditions for separation in the solid phase of the higher complexes listed was determined. The formation of the peroxofluoride complex compounds of uranyl ions takes place in weakly acid media and in media close to neutrality, i.e., in the pH range for the formation of fluoride complexes of the uranyl ion. It was established that the formation of the peroxofluoride complexes in the system $UO_2(NO_3)_2$–MF–H_2O_2–H_2O proceeds by replacement of the fluoride group, coordinated around the uranyl ion, with peroxo groups or by means of the replacement of the aquagroups from aquadiperoxodiuranyl with fluorine ions. The stability of the bonds of the peroxogroup with uranyl was significantly higher than that of the fluoride group. The thermal instability of the peroxofluoride complexes was shown and a mechanism for their thermal decomposition was proposed. (tr-auth)

32174 NEW URANIUM OXALIC SALTS. Grinberg, A. A.; Lozhkina, G. S. Radiokhimiya, 9: 179-83(1967). (In Russian).

A complex compound, the tetraoxalato uranium of tetrammine platinum(II) $[Pt(NH_3)_4]_2[U(C_2O_4)_4] \cdot 3H_2O$, was synthesized. The differential titration of this salt was investigated in detail. (tr-auth)

32175 DISPROPORTIONATION OF PLUTONIUM(V) IN OXALATE SOLUTIONS. Ermolaev, N. P.; Krot, N. N.; Gel'man, A. D. Radiokhimiya, 9: 171-8(1967). (In Russian).

By the spectrophotochemical method, the kinetics and mechanism of the disproportionation of Pu(V) in oxalate solution was investigated for a wide range of pH, concentration of $C_2O_4^{2-}$ ions, and temperature. In oxalate solution, Pu(V) disproportionated irreversibly and only with the formation of tetra- and hexavalent Pu. The reaction rate is described by equations of the second order. The apparent value of the activation energy at $(NH_4)_2C_2O_4$ concentrations of 0.123M and pH of 3.1 to 3.7 is 13.7 kcal/mol. The effect of the $(NH_4)_2C_2O_4$ concentration and pH on the disproportionation rate of Pu(V) was investigated. On the basis of the data obtained, a mechanism was proposed for the disproportionation, taking into consideration the complex formation of Pu(V) with oxalate ions. From kinetic data the values of the stability constants and the disproportionation rate of the complex plutonium oxalates with the composition $PuO_2HC_2O_4$, $PuO_2C_2O_4^-$, and $PuO_2(C_2O_4)^{3-}$ were calculated. (tr-auth)

32176 COMPLEX FORMATION OF Am, Cm, Cf, AND Fm WITH LACTIC ACID. Ermakov, V. A.; Stary, I. Radiokhimiya, 9: 197-201(1967). (In Russian).

The extraction constants of Am (log K = −7.97), Cm (log K = −7.84), Cf (log K = −7.11), and Fm (log K = −6.80) with thenoyltrifluoroacetone with benzene as the solvent were determined. The composition was investigated and the stability constants of lactate complexes of Am (log β_3 = 6.71), Cm (log β_3 = 6.76), Cf (log β_3 = 6.09), and Fm (log β_3 = 6.36) were determined by the extraction method. The stability constants of lactate complexes of Cm (log β_3 = 5.78), Cf (log β_3 = 6.08), and Fm (log β_3 = 6.27) were determined by the ion exchange method. (tr-auth)

32177 AMERICIUM, CURIUM, AND PROMETHIUM COMPLEX FORMATION WITH TRIMETAPHOSPHORIC ACID. Elesin, A. A.; Lebedev, I. A.; Piskunov, E. M.; Yakovlev, G. N. Radiokhimiya, 9: 161-6(1967). (In Russian).

The second and third dissociation constants of trimetaphosphoric acid were determined by potentiometric titration at 25°C and μ = 0.2 to be equal to 1.639 and 2.072. The sorption of americium, curium, and promethium on the cation exchange resin Dowex-50 × 8 from solutions of trimetaphosphoric acid was investigated at pH 2 and 4. It was established that under the conditions given complex ions of the form $MP_3O_9^{3-}$ and, possibly, $MHP_3O_9^{2+}$ were formed. The stability constants of the complexes $AmP_3O_9^{3-}$, $CmP_3O_9^{3-}$, and $PmP_3O_9^{3-}$ were calculated as 3.0×10^3, 4.4×10^3, and 6.3×10^3, respectively, at μ = 0.2 and 25°C. (tr-auth)

32178 STUDIES OF TETRA- AND TRIALKYLAMMONIUM URANYL TRIACETATE IN ORGANIC SOLVENTS. Lipovskii, A. A.; Kuzina, M. G. Zh. Neorg. Khim., 12: 1240-5(May 1967). (In Russian).

The polymerization of tetradecyl- and trioctyl-ammonium uranyl triacetates, as a function of their concentration in benzene, was analyzed using spectroscopic and cryoscopic methods. The difference in polymerization is caused by the reduced dipole–dipole reaction in the case of ion pairs with hydrogen bond. The degree of polymerization of trialkylammonium salts in benzene is in inverse proportion to the hydrogen bond force. Electron and infrared absorption spectra of tetradecyl- and trioctyl-ammonium uranyl triacetates were measured in a series of organic solvents. The absorption spectra for $R_4NUO_2AC_3$ did not vary and remained identical for all investigated solvents. (R.V.J.)

32179 REACTION OF URANYL THIOCYANATE COMPLEXES WITH SOME NEUTRAL LIGANDS. Shchelokov, R. N.; Shul'gina, I. M.; Chernyaev, I. I. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim., 12: 1246-54(May 1967). (In Russian).

The synthesis and reactions of substitution in uranyl thiocyanate compounds with oxygen- and nitrogen-containing ligands were studied. Some data are given on the properties of the complexes $[UO_2(NCS)_2L_2(H_2O)]$, where L is $CO(NH_2)_2$ or $CO(NH_2)(CH_3)$; $[UO_2(NCS)_2L'_2]$ (where L' is $CO(NH_2)_2$, antipyrine, DMSO (dimethyl sulfoxide), Thf (tetrahydrofuran); $M[UO_2(NCS)_3(CO(NH_2)_2)]$, (where M is Cs, CN_3H_6). The data on the synthesis, electric conductivity and ir spectra confirm the postulation on uranyl pentacoordination in these compounds. It was also found that during reactions of triaquadithiouranyl with 1.10-phenanthroline and α,α'-dipyridyl in methanol solutions form compounds of the following composition: $[UO_2Phen_3(NCS)]NCS$ and $[UO_2Dipy_2(NCS)] \cdot NCS$ in which uranyl pentacoordination takes place. (R.V.J.)

32180 MELTING IN BINARY SYSTEMS FORMED BY TUNGSTEN HEXACHLORIDE AND OXYTETRACHLORIDE WITH Nb, Ta, Sb(III), AND Bi CHLORIDES. Korshunov, B. G.; Bezuevskaya, V. N. (Moscow Inst. of Fine Chemical Tech.). Zh. Neorg. Khim., 12: 1304-6(May 1967). (In Russian).

Thermal analysis of melting in WCl_6–$BiCl_3$, WCl_6–$SbCl_3$, $WOCl_4$–$BiCl_3$, $WOCl_4$–$SbCl_3$, $WOCl_4$–$NbCl_5$, and $WOCl_4$–$TaCl_5$ showed that all the systems studied belong to the eutectic type. (R.V.J.)

32181 CONTRIBUTION ON THE SOLUBILITY OF OXYGEN IN LIQUID SODIUM. Claxton, K. T. (Atomic Energy Research

Establishment, Harwell, Eng.). J. Nucl. Energy, 21: 351-7 (Apr. 1967).

A re-appraisal of existing solubility data for the sodium–oxygen system using a new value of 1132°C for the melting point of sodium monoxide (Na_2O) was carried out. The improved statistical accuracy found is taken as providing partial confirmation of this new figure. New solubility data from the Los Alamos laboratories have been analyzed, and a definite change of slope in the log(solubility) vs 1/T°K plot detected is at a temperature of about 215°C. (auth)

32182 DETERMINATION OF PLUTONIUM OXIDATION STATES IN DILUTE NITRIC ACID BY COMPLEMENTARY TRISTIMULUS COLORIMETRY. Silver, Gary L. (Mound Lab., Miamisburg, Ohio). Talanta, 14: 637-41(June 1967). (MLM-1383J).

The preparation of reference standards for use in complementary tristimulus colorimetry for Pu is described. Pu(III) and (VI) were prepared by hydrazine reduction and Ag(II) oxidation, respectively, of Pu(IV). Plutonium(V) was prepared by reduction of Pu(VI) with ascorbic or sulfurous acid. A method for computerizing tristimulus colorimetry is presented, and the technique is extended to three dimensions ("quadristimulus colorimetry"). (auth)

32183 AMINE EXTRACTION AND DETERMINATION OF ACTIVITY COEFFICIENTS OF NEPTUNIUM AND PLUTONIUM NITRATES. Alian, A.; Haggag, A. (Atomic Energy Establishment, Cairo). J. Inorg. Nucl. Chem., 29: 1355-63(May 1967).

The stability constants of the extracted amine complexes of Np(IV) and (VI) and Pu(IV) nitrates were estimated. Approximate values of the activity coefficients of these metal nitrates in the aqueous phase were evaluated at different HNO_3 molarities. The comparative stabilities of the amine-metal nitrate complexes were determined. Extraction of Np(IV) nitrate in the presence of different anions and cations was also investigated. (auth)

32184 THE PURE QUADRUPOLE SPECTRUM OF THE ^{197}Au NUCLEUS IN THE COMPOUND AuCl. Machmer, P.; Read, M.; Cornil, P. (Univ. of Liege). Inorg. Nucl. Chem. Lett., 3: 215-17(June 1967).

The pure quadrupole transition of ^{197}Au was observed. The compound AuCl exhibits a triplet and the pure quadrupole coupling constant is determined as 514 MHz. This value is discussed with reference to the chemical bonding in this molecule. (UK)

32185 MEASUREMENT OF SOLVENT ISOTOPE EFFECTS WITH THE GLASS ELECTRODE. PART I. THE IONIC PRODUCT OF D_2O AND D_2O–H_2O MIXTURES. Gold, V.; Lowe, B. M. (King's Coll., London). J. Chem. Soc. (A), No. 6, 936-43(1967).

The ionic product of D_2O and D_2O-H_2O mixtures was determined by means of a cell with glass and Ag–AgCl electrodes and without liquid junctions. Experimental data were obtained from a study of the stepwise addition of $Ba(OH)_2$ solution to HCl, which was initially in the cell. A computer program was used to evaluate the data and to assist in the minimization of uncertainties associated with the glass electrode and the electrolyte composition. The isotope effect, $\Delta pK_n = pK_n - pK_H$, is given by the equation $\Delta pK_n = 0.7282n + 0.0512n^2 + 0.0826n^3$. Interpretations based on a monosolvated proton are superior to those in which the solvation is unspecified. There is some evidence for fractionation processes associated with water molecules in the solvent shells of H_3O^+ and OH^- ions, or for some other form of medium effect. (auth)

32186 KINETIC STUDY OF THE REACTION BETWEEN NITROUS ACID AND SULPHAMIC ACID. Hughes, M. N. (Queen Elizabeth Coll., London). J. Chem. Soc. (A), No. 6, 902-5(1967).

Kinetics of the reaction between nitrous acid and sulphamic acid were studied at three temperatures over the acidity range pH 5 to 3M-$[H^+]$. At acidities lower than 0.248M-$[H^+]$ reaction only occurred by the attack of the nitrous acidium ion on sulphamate ion. Attempts to catalyse other nitrosation pathways failed. This exclusive, although low, reactivity of the suphamate ion for the nitrous acidium ion is discussed. Increase of acidity to 3M-$[H^+]$ resulted in the introduction of another reaction pathway involving sulphamic acid. The deuterium solvent isotope effect is discussed. (auth)

32187 STUDIES OF THE POLYANIONS AND POLYCATIONS BY GLAUBER'S-SALT CRYOSCOPY. PART II. POLYCATIONS OF URANIUM. Jain, D. V. S.; Jain, C. M.; Vaid, R. N. (Panjab Univ., Chandigarh, India). J. Chem. Soc. (A), No. 6, 915-16(1967).

Depression in the transition temperature of Glauber's salt owing to the presence of UO_2^{2+} and other polycations of U formed by the hydrolysis of UO_2^{2+} was measured at different pH values. The average degree of condensation calculated from these measurements appeared to confirm the existence of polycations with the general formula $UO_2[(OH)_2UO_2]_n^{2+}$ with $\bar{n}$ increasing rapidly above pH 5. (auth)

32188 STUDY OF THE ISOTOPIC EXCHANGE REACTION OF ^{18}O OF CARBON WITH THE OXYGEN IONS OF NICKEL OXIDE. Bailly, J. Cl.; Gravelle, P. C.; Teichner, S. J. (CNRS, Lyon. Univ., Lyon). Bull. Soc. Chim. France, No. 5, 1620-7 (May 1967). (In French).

Carbon monoxide containing ^{18}O exchanges with the ^{16}O in nickel oxide starting at room temperature. The fraction of the surface of NiO which participates in this exchange (0.2) is slightly greater than the fraction covered by the irreversibly adsorbed CO. Results indicate that the reaction of CO upon NiO which leads to CO_2 formation cannot be the intermediate step in the exchange process. (auth)

32189 ^{14}N CHEMICAL SHIFTS IN SOME BENZOTHIAZOLES. Mathias, A. (Imperial Chemical Industries Ltd., Manchester, Eng.). Mol. Phys., 12: 381-4(1967).

Nitrogen-14 chemical shift values were measured in benzothiazole and some derivatives using the double irradiation method. It was found that ^{14}N chemical shifts can be used to decide the structures of two-substituted benzothiazoles, where tautomerism involving the thiazole and thiazoline forms is possible. (auth)

Radiation and Nuclear Chemistry

Refer also to abstracts 32218, 32219, 32335, and 33526.

32190 (AD-654502) COMPUTER PROGRAM FOR KINETIC TREATMENT OF RADIATION CHEMICAL DATA. Klein, Nathan (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). June 1967. 26p. (NDL-TM-36). Dep. CFSTI.

The computer program was designed to help in the evaluation of data in radiation chemistry. Although the program, PR III, was specifically designed for data evaluation in pulse radiolysis, it may be modified to process data obtained with much lower dose rates than those encountered in pulse radiolysis, e.g., radioisotope radiation sources. The program assumes that all reactive species are homogeneously distributed in solution and requires as input the initial concentration of all species that will "react" during the course of the calculation. In addition, the yield of all species produced by the radiation is a required input. (auth)

32191 (NP-16834) RADIATION GRAFT COPOLYMERIZATION. Technical Report No. 3567. Holahan, F. S.; Levi, D. W. (Picatinny Arsenal, Dover, N. J. Feltman Research Labs.). June 1967. 123p. CFSTI.

Radiation graft polymerization is reviewed for the period between the late nineteen fifties and the middle of 1966. Included are descriptions of studies related to the various types of grafting reactions, the evaluation of factors important in grafting reactions, and properties of the grafted polymers. The various topics discussed include grafting on polyethylene; grafting on polypropylene; grafting on other hydrocarbon polymers; grafting on halogen-containing polymers; grafting on nitrogen containing polymers; grafting on polymers containing alcohol, acid, and ester groups; grafting on silicon-containing polymers; grafting on cellulose and its derivatives; grafting on natural polymers and derivatives. Subject and author indexes are included. (P.C.H.)

32192 ELECTRON HOLE PAIRS IN THE IRRADIATION OF CONDENSED SYSTEMS. Weiss, J. J. (Univ. of Newcastle-upon-Tyne, Eng.). Nature (London), 215: 150-1(July 8, 1967).

Recent studies on gamma-irradiated frozen aqueous solutions at 77°K led to elucidation of the kinetics of the reactions of electrons and holes produced by irradiation. Recent experimental results suggest that the electron hole pair model proposed for ice is also applicable to aqueous and non-aqueous systems. Since the absorption spectra of the unstable intermediate in ice and liquid water are practically identical, it must be concluded that essentially the same species are involved. The model of a bound electron hole pair, that is, an exciton of small radius, is fully compatible with the observations. Gamma irradiation of a condensed system would in the first instance lead to free electrons and holes, but after a relatively short time the electrons could be captured by the holes into an exciton of small radial extension. The observed chemical reactions of electrons and holes would then be caused by scavenging, by suitable solute molecules, of either of these species from the exciton state. Experimental observations relating to the "solvated electron" can be explained satisfactorily on the basis of the electron hole pair model discussed. (UK)

32193 THE X-RADIOLYTIC DESTRUCTION OF LIPOIC ACID IN AQUEOUS SOLUTION: A CHAIN REACTION. Owen, T. C.; Wilbraham, A. C. (Univ. of South Florida, Tampa). Chem. Commun., No. 13, 624-5(1967).

Irradiation of aerated aqueous solutions of 6-thioctic acid (α-lipoic acid), at concentrations 0.4 to 8.3M and pH 3.5 to 5.0, with 125 kVp x-rays at a dose rate of 3565 RAD/min produced a pro-

gressive diminution in the absorption (λ_{max} 330 mμ) of the dithiacyclopentane chromophore. Absorption below 290 mμ increased concomitantly, eventually showing a shoulder at 240 to 245 mμ and an isosbestic point at 294 mμ, which was sharp at least up to destruction of a third of the lipoate initially present. Initial decomposition rates (G_0) were markedly concentration dependent and unusually high, ranging from 4.8 to 25.8 molecules/100 eV. At the highest concentration employed G_0 was several times larger than $G_H + G_{OH} = G_{H_2O_2}$ and six to twenty times as great as typical yields for destruction of acyclic disulphides in aerated aqueous solution. It was concluded that lipoate destruction occurs by a chain reaction, possibly polymerization. Interpretation of the mechanism of the chain reaction awaits further investigation, and also the nature of the radiolysis products. (UK)

32194 EFFECTS OF OLEFINS ON THE RADIOLYSIS OF LIQUID CYCLOHEXANE. I. Cramer, W. A.; Piet, G. J. (Reactor Instituut, Delft, Netherlands). Trans. Faraday Soc., 63: 1402-7(June 1967).

Solutions of ethylene in cyclohexane were irradiated with ^{60}Co γ rays. Some experiments were carried out in the presence of oxygen, carbon tetrachloride, or ammonia. The results indicated that ethylene reacted with hydrogen atoms to form radicals, which were precursors to ethane and ethylcyclohexane formation. These products were also formed by reactions between cyclohexane positive ions and ethylene. The contribution of these ion–molecule reactions can be enhanced by addition of electron scavengers, such as carbon tetrachloride, and reduced in the presence of ammonia. It was concluded that thermal hydrogen atoms are formed in irradiated cyclohexane with a yield equal to or smaller than 0.8. (auth)

32195 APPLICATION OF A POTENTIOSTATIC METHOD IN THE INVESTIGATION OF WATER RADIOLYSIS IN PRESENCE OF SOME RADICAL ACCEPTORS. Pangarov, N.; Raichevski, G. (Inst. of Physical Chemistry, Sofia). Compt. Rend. Acad. Bulg. Sci., 20: 205-8(1967).

The formation and properties of products obtained during x irradiation (200-kV) in 0.8N H_2SO_4, containing H_2O_2 or O_3 concentrations, were investigated by means of a potentiometric method. The irradiation lasted 10 to 20 sec with a dose strength of 3×10^{16} eV/ml sec. The total current was plotted against time of irradiation at three concentrations of added H_2O_2. A linear relationship between strength of current and dose of irradiation was found at an acceptor concentration of $5 \times 10^{-5} NH_2O_2$. Data are presented to prove the formation and existence of HO_2 radicals during water radiolysis in the liquid phase, as well as being one of the primary products during irradiation with a high LET. (D.H.M.)

32196 RADIATION EFFECTS ON AMINO ACIDS: VALINE. Box, Harold C.; Freund, Harold G.; Budzinski, Edwin E. (Roswell Park Memorial Inst., Buffalo). Contract AT(30-1)-3558. J. Chem. Phys., 46: 4470-3(June 1, 1967). (NYO–3558-11).

Single crystals of DL-valine were x-irradiated at liquid nitrogen temperature. The ESR absorption spectrum was observed as the crystal warmed. After warming to 225°K, a definitive spectrum was obtained, which is attributed to the formation of the free radical $(CH_3)_2CHCHCOOH$. A transformation of the absorption occurred at room temperature due to the formation of the free radical $(CH_3)_2CCH(NH_3^+)COO^-$. This radical was examined by ESR and ENDOR spectroscopy. (auth)

32197 PREPARATION OF ^{83}Br COMPOUNDS AND CARRIER-FREE ^{83m}Kr. Sonnino, T.; Pasternak, M. (Soreq Nuclear Research Center, Israel). Int. J. Appl. Radiat. Isotop., 18: 535-7 (July 1967).

The preparation of ^{83m}Kr by neutron irradiation of ^{82}Se in natural selenium, which contains 9% of the isotope-82, is described. The ^{83}Se formed decays to 2.4-hr ^{83}Br which in turn decays to ^{83}Kr. Chemical procedures and results are presented. (J.G.B.)

32198 CHEMISORPTION ON SOME ALKALINE EARTH OXIDES. PART 1. SURFACE CENTRES AND FAST IRREVERSIBLE OXYGEN ADSORPTION ON IRRADIATED MgO, CaO, AND SrO. Nelson, R. L.; Tench, A. J.; Harmsworth, B. J. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Faraday Soc., 63: 1427-46(June 1967).

A fast irreversible adsorption of oxygen at 20°C on γ- or neutron-irradiated MgO or CaO was correlated with observable surface paramagnetic centers (S centers) and colour centres. The S centre in MgO with $g_{av} = 2.0007$ is believed to be an intrinsic defect consisting of an electron trapped at a surface anion vacancy. An additional oxygen-sensitive signal S_H was related to the presence of some hydrogen contamination on the surface. The S centre in CaO, with $g_{||} = 1.9992$ and $g_{\perp} = 1.9969$ after γ-irradiation to low doses, is similar in behavior to that on MgO; at high γ-doses or after neutron irradiation, however, a complex signal is produced. A surface centre with $g_{av} = 1.9798$ and of low intensity was detected on γ- and neutron-irradiated SrO, but this accounts for only a small fraction of the total oxygen adsorption on SrO. The formation of anion vacancies at the surfaces of unirradiated and irradiated oxides is discussed. These defects play a dual role in the irreversible adsorption of oxygen by providing a trap for an electron at the surface and a site capable of stabilizing the adsorbed oxygen species; other sites for oxygen adsorption are increasingly important in CaO and SrO, and account for adsorption on the unirradiated oxides. (auth)

32199 RADIATION-INDUCED POLYMERIZATION BY FREE IONS. PART 1. POLYMERIZATION OF STYRENE UNDER ANHYDROUS CONDITIONS. Ueno, Katsuji; Williams, Ffrancon; Hayashi, Koichiro; Okamura, Seizo (Kyoto Univ.). Trans. Faraday Soc., 63: 1478-88(June 1967).

The radioinduced ionic polymerization of bulk styrene was studied under extremely dry conditions. The rate R_p of polymerization increased with more rigorous drying of the monomer, and this effect was accompanied by a change in the exponent n for the dose-rate (I) dependence of R_p, from n values near unity to 0.6 ($R_p \propto I^n$). A mechanism involving bimolecular termination of free ions is indicated. The strong retardation of polymerization by scavengers of high proton affinity such as water, diethyl ether, ammonia, and trimethylamine in low concentrations (10^{-3} to 10^{-6} M) provides evidence that free cations are mainly responsible for the propagation. The addition of nitrous oxide did not affect R_p and did not appear to prevent electron capture by styrene. Individual reaction steps for cationic and anionic mechanisms are discussed, and the initiation is considered to occur through the respective monomeric ion radicals M^+ and M^-. It was concluded that the predominance of cationic over anionic polymerization is due to faster initiation and/or propagation processes in the former case. (auth)

32200 A COMPILATION OF SPECIFIC BIMOLECULAR RATE CONSTANTS FOR THE REACTIONS OF HYDRATED ELECTRONS, HYDROGEN ATOMS, AND HYDROXYL RADICALS WITH INORGANIC AND ORGANIC COMPOUNDS IN AQUEOUS SOLUTION. Anbar, M.; Neta, P. (Weizmann Inst. of Science, Rehovoth, Israel. Soreq Nuclear Research Center, Rehovoth, Israel). Int. J. Appl. Radiat. Isotop., 18: 493-523(July 1967).

The data, presented in tabular form, relate to available kinetic data on the reactivities of the primary species of radiolyses in aqueous systems, and form a revision and extension of the compilation published in 1965 (loc. cit. 16: 227(1965)). Most of the newer values were obtained by pulse radiolysis techniques. Some hitherto unpublished data are included. The values relate to 15 to 25°C. (164 references). (UK)

32201 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID STATE POLYMERIZATION. XX. CHARACTERISTICS OF THE γ-RAY INITIATED SOLID STATE POLYMERIZATION OF N-VINYLSUCCINIMIDE. Hardy, Gy.; Varga, J.; Nagy, G.; Cser, F.; Eroe, J. (Polytechnical Univ., Budapest. Central Research Inst. for Physics, Budapest). Acta Chim. Acad. Sci. Hung., 52: 305-18(1967).

The solid-state polymerization of N-vinylsuccinimide gives an amorphous polymer whose physical and chemical structure is identical with that of the product obtainable by polymerization in the liquid phase. The properties of the polymer, examinations by ESR spectroscopy, as well as earlier kinetic investigations, showed that N-vinylsuccinimide belongs to the class of monomers "non-polymerizing in the crystal lattice." A kinetic equation was derived to account for the accelerating character of the polymerization kinetical curves of this type of monomers. This equation takes into consideration the accumulation of free radicals and the influence of the amorphous polymeric phase produced during the reaction. (auth)

32202 PULSE-RADIOLYTIC INVESTIGATIONS OF THE REACTIONS OF ORGANIC RADICALS WITH HYDROGEN SULFIDE. Karmann, W.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin. Sektor Strahlenchemie, Berlin). Ber. Bunsenges. Phys. Chem., 71: 421-4(June 1967). (In German).

Reactions of α-alcohol radicals (methyl, ethyl, n- and isopropyl alcohols) and the tert butyl alcohol radical with H_2S in aqueous solution by H-atom abstraction were studied. The rate is less than proportional to the H_2S concentration. This effect is explained by assuming an equilibrium $R + H_2S \rightleftharpoons RSH_2$ with subsequent decomposition of the complex according to $RSH_2 \rightarrow RH + SH$. The equilibrium and decay constants were determined for several alcohols. The reaction of the methyl alcohol radical with H_2S was also studied in methanol solutions. CH_3OH reacts with H_2S but does not react with SH^-. (auth)

32203 STEREOREGULARITY OF POLY(ACRYLIC ACIDS) OBTAINED BY RADIOCHEMICAL POLYMERIZATION IN THE

LIQUID AND CRYSTALLINE PHASES. Chapiro, Adolphe; Sommerlatte, Tom (CNRS, Bellevue, France). Compt. Rend., Ser. C, 264: 1825-7(June 5, 1967). (In French).

Radiochemical polymerization of acrylic acid crystallized between −16 and +8°C gives rises to a mixture of stereoisomers: an atactic polymer and an isotactic polymer. This latter represents only about 20% of the total polymer. Irradiation of the liquid monomer between +20 and +76°C leads principally to the isotactic polymer. The isotactic polymers obtained were crystallizable. Their structure was studied by means of the polarizing microscope, the electron microscope, and by x-ray diffraction. Results are discussed. (tr-auth)

32204 PRODUCTS OF BENZENE RADIOLYSIS AS EXCITATION ACCEPTORS. Gurskii, M. N.; Deryunova, V. P. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uz. SSR, No. 2, 22-5(1967). (In Russian).

A spectral luminescence method was used to determine the process in which the low concentration radiolysis products (10^{-4} to 10^{-3} mole/l) deactivated benzene molecules found at the lower singlet excitation level. The luminescence spectra of irradiated benzene were studied over the wavelength range from 2700 to 4900 Å. With the excitation line 3100 Å there appeared a wide spectrum with three bands with increasing intensity indicating the accumulation of radiolysis products with the increased dose while the intensity of the benzene luminescence intensity weakened. The damping of the benzene photoluminescence was at the expense of the accumulation of radiolysis products and implied that products act as excitation acceptors. The damping constant and the lifetime of excited benzene molecules, $\tau = 2.6 \times 10^{-8}$ sec, were used to find the rate of excitation transition or the possible transfer of excitation from benzene to the products. (R.V.J.)

32205 RADIOLYSIS OF POLY(ETHYLENE TEREPHTHALATE): INFLUENCE OF AIR. Campbell, D.; Turner, D. T. (Research Triangle Inst., Research Triangle Park, N. C.). J. Polym. Sci. Pt. B, 5: 471-5(June 1967).

An investigation was made of the γ radiolysis of poly(ethylene-terephthalate) (PET). Some of the samples were degassed and sealed in vacuo at 10^{-5} mm Hg and others were placed in glass tubes with free access to air. One week after irradiation the samples were removed from the tubes, the carboxyl groups estimated, and viscosity and light absorption measured. The large change in $[\eta]$ indicated that oxygen suppressed crosslinking but increased the number of fractures. This was accompanied by an increase in the yield of carboxyl groups. Based on the viscosity data obtained after suppression of a concurrent crosslinking reaction with oxygen, it was concluded that the degradation of PET by γ resulted in the formation of close to 1 carboxyl group per fraction. (D.H.M.)

32206 ELECTRON PARAMAGNETIC RESONANCE SPECTRA OF THE RADICALS FORMED BY RADIOLYSIS OF NITROALKANES IN THE SOLID PHASE. Chachaty, Claude; Rosilio, Charles (CEN, Saclay, Gif-sur-Yvette, France). J. Chim. Phys., 64: 777-90(May 1967). (In French).

The ESR spectra of two kinds of nitroradicals were observed after γ irradiation of nitroalkanes in the solid phase. The first ($R\dot{C}HNO_2$), produced in the case of nitromethane and nitroethane were characterized by $\alpha_H^\beta = 21 \pm 1$ and $\alpha_N = 6 \pm 1$ G. The comparison of the experimental values with those deduced from computed spin densities suggests that $\dot{C}H_2NO_2$ and $CH_3\dot{C}HNO_2$ radicals and nonplanar. By γ irradiation of the higher homologues, or generally of nitroalkanes in glassy ethanol, radicals are produced from addition reactions to the nitro-group. The nitrogen hyperfine coupling is in this case, very anisotropic, the principal values of A_N are: $A_{N||} = 48$ G and $A_{N\perp} = 18$ G, ($\alpha_N = 28$ G). It was found that, in ethanol, these last radicals are formed by scavenging of electrons. H· atoms and $CH_3\dot{C}HOH$ radicals. (auth)

32207 RADIATION-INDUCED BULK POLYMERIZATION OF MALEIMIDE. Kagiya, Tsutomu; Izu, Masatsugu; Kawai, Shunzo; Fukui, Kenichi (Kyoto Univ.). J. Polym Sci., Pt. A-1, 5: 1415-23(June 1967).

Radioinduced bulk polymerization of maleimide in both solid and liquid states was studied. Benzoquinone inhibited the liquid-state polymerization and retarded solid-state polymerization. The results of an ESR study showed that solid monomer irradiated at 61°C gave a spectrum, the concentration of which slowly decreased without changing the shape. The radical detected at 61°C was shown not to be the main propagating species. Overall-rate polymerizations in the liquid and solid states were expressed, respectively, by first-order and zero-order rate equations with respect to the concentration of monomer. The overall-rate constants in liquid and solid states were proportional to $I^{0.5}$ and $I^{1.0}$, respectively. (auth)

32208 FLOW METHOD STUDY OF THE GAMMA-RAY-INDUCED POLYMERIZATION OF ETHYLENE. Kawakami, Waichiro; Hosaki, Yoshihiko; Hagiwara, Miyuki; Machi, Sueo; Kagiya, Tsutomu (Japan Atomic Energy Research Inst., Gumma). Ind. Eng. Chem., Process Design Develop., 6: 302-8(July 1967).

The γ-induced gas-phase polymerization of ethylene in a flow system was carried out in a 1-liter continuously stirred tank reactor surrounded by a source of 54,000 Ci of ^{60}Co. The polymerization was studied quantitatively by measuring the reaction rate and the molecular weight of the polymer at a temperature of 30°C, a pressure of 400 kg per sq cm gage, a dose rate of 3.8×10^5 RAD per hr, and various flow rates. On increasing the flow rate from 300 to 3000 normal liters per hr, the reaction rate decreased from 0.51 to 0.31 C_2H_4 mole per liter of reactor-volume per hour, and the molecular weight decreased from 9.1 to 5.8×10^4 grams per gram-mole. Results indicated that a reaction in a flow system can be kinetically treated by the use of rate constants obtained in a batch system, and that the residence time of a polymer in the reactor is not equal to the value of reactor volume divided by the volumetric gas flow rate. This ratio increased from 0.52 to 2.46 with an increase in flow rate. (auth)

32209 ALPHA RADIOLYSIS OF AQUEOUS SOLUTIONS OF NITRIC ACID. Savel'ev, Yu. I.; Ershova, Z. V.; Vladimirova, M. V. Radiokhimiya, 9: 225-30(1967). (In Russian).

During the investigation of the α radiolysis of 0.01 to 6.0M solutions of nitric acid, the radiation yields of HNO_2, H_2O_2, H_2, O_2, N_2, and NO were determined in relation to the concentration of the acid. Formulas are proposed for calculation of the radiation yields of H_2 and N_2 from HNO_3 solutions exposed to α radiation. The decrease of the reducing capacity of hydrogen atoms with increase of the HNO_3 concentration was established. (tr-auth)

32210 IMPEDANCE AT THE MERCURY/SOLUTION INTERFACE IN GAMMA RADIATION. Minc, S.; Sobkowski, J. (Univ. of Warsaw). Electrochim. Acta, 12: 873-7(July 1967).

The impedance of the interface mercury/electrolyte solution was measured for $NaClO_4$, $NaNO_3$, Na_2SO_4, NaCl, and NaI solutions when the interface is exposed to gamma rays. In all cases radiation led to a decrease in the differential capacitance, most probably through the formation of films of stable radiolysis products. (auth)

32211 TRANSIENT CHARGE-TRANSFER COMPLEXES WITH CHLORINE ATOMS BY PULSE RADIOLYSIS OF CARBON TETRACHLORIDE SOLUTIONS. Buehler, R. E. (Technische Hochschule, Zurich); Ebert, M. Nature, 214: 1220-21(June 17, 1967).

Charge-transfer complexes of Cl atoms, formed during the pulse radiolysis of CCl_4 solutions of aromatic compounds, are reported. These transient species were detected by kinetic spectroscopy in the visible range of the spectrum. The dose in a single pulse of 4-MeV electrons (100 ma and 2 μsec pulse length) was about 6 kR, and the time resolution was better than 0.4 μsec. The solute concentrations were in most cases between 10^{-4} and 10^{-2} molar. Any direct effect of the ionizing radiation on the solute was therefore negligible. In a solution of 10^{-2} molar benzene the electron pulse produced a transient absorption centered at 490 nm, with a half-width of about 50 nm, and a lifetime of 3.9 μsec. (for an assumed first order decay). Results are given for a number of aromatic solutes in CCl_4. Plots are shown for the absorption energies of the charge-transfer complexes against the ionization potentials of the electron donors; these plots should give straight lines. The absorption bands of the complexes were unaffected by the presence of O_2. The question whether the CCl_3 radical from the solvent would be able to produce the transient absorption in the visible was examined by comparing pulse radiolysis results for the systems pure chlorobenzene and 10^{-2} molar chlorobenzene in CCl_4. The absorption band centered at 490 nm was identifiable in both systems; the CCl_3 radical could not therefore be the precursor. The high quenching characteristics of CCl_4 also make it unlikely that excited states persist for as long as 10^{-6} sec and are the transient absorptions. The electron donors do not all have the same reactivity towards halogen attack, and this sometimes limits the detectability of charge-transfer complexes. Results are shown for changing the solvent to $CHCl_3$ and CH_2Cl_2. This leads to a drastic reduction in the yield of Cl atom charge-transfer complex, which might be explained by increasing reactivity for H abstraction from the solvent. (UK)

32212 ELECTRON PARAMAGNETIC RESONANCE SPECTRA OF SOME IRRADIATED AMINO ACIDS. Mochalkin, A. I. Sb. Tr. Agron. Fiz., Vses. Akad. Selskokhoz. Nauk, 12: 152-62(1965). (In Russian).

The effects of temperature on the electron paramagnetic resonance (EPR) spectra of γ-irradiated amino acids were investigated. The concentration of free radicals decreased gradually with increasing temperature in all the amino acids except histidine, in which the signal was slightly increased at about 80°C, did not change with increasing temperature, and then became sharply diminished at 160 to 180°C. The EPR spectra of threonine and valine became simpler at higher temperature, but new lines ap-

peared in the spectra of lysine. The spectra of phenylalanine and arginine showed no change. The radiation quantum yield was estimated for several amino acids and the integral spectra of absorption of high-frequency radiation were constructed. (D.H.M.)

Radiochemistry

Refer also to abstracts 32229, 32645, and 32666.

32213 (NAS-NS-3111) CHEMICAL YIELD DETERMINATIONS IN RADIOCHEMISTRY. Norton, Elinor F. (Brookhaven National Lab., Upton, N. Y.). [nd]. 95p. Dep. CFSTI.

Nuclear Science Series of the National Academy of Sciences–National Research Council, Washington, D. C. Committee on Nuclear Science.

Procedures for determination of yields of radiochemical separations are presented with emphasis on spectrophotometric or flame photometric methods. (M.C.G.)

32214 (PRNC-101) HOT-ATOM CHEMISTRY PROGRAM. Progress Summary Report No. 2, April 1966–March 1967. Wheeler, Owen H. (Puerto Rico Nuclear Center, Mayaguez). Contract AT(40-1)-1833. 62p. Dep. CFSTI.

Hot-atom reactions in organic compounds with multiple covalent bonds between carbon and activated atoms are being studied. Analytical procedures were studied, including column, paper, ion-exchange, thin-layer, and vapor-phase chromatography, and paper and thin-layer electrophoresis. The following nuclear reactions are being used: $^{31}P(n,\gamma)^{32}P$, $^{34}S(n,\gamma)^{35}S$, $^{32}S(n,p)^{32}P$, $^{202}Hg(n,\gamma)^{203}Hg$, $^{209}Bi(n,\gamma)^{210}Bi$, $^{124}Sn(n,\gamma)^{125}Sn \rightarrow {}^{125}Sb$, $^{203}Tl(n,\gamma)^{204}Tl$, $^{127}I(n,\gamma)^{128}I$, and $^{80}Se(n,\gamma)^{81}Se$ in phenyl derivatives of these elements. (M.C.G.)

32215 RECOIL TRITIUM REACTIONS IN METHANE–HYDROGEN MIXTURES: CH_4–D_2. Root, John W.; Rowland, F. S. (Univ. of Kansas, Lawrence. Univ. of California, Irvine). Contract AT(11-1)-407. J. Chem. Phys., 46: 4299-4305(June 1, 1967).

The reactions of recoil tritium atoms were studied over the full range of mole fractions for mixtures of CH_4 with D_2 and show total hot yields varying from 53 and 93% as the mole fraction of D_2 increased. The specific activity ratio $(CH_3T)/(CH_4) : (DT)/(D_2)$ was approximately constant over the entire range, indicating that these reactions occur at similar average energies. All of the data can be quantitatively explained through use of the kinetic theory of hot reactions. The moderating ability of CH_4 was more than twice that of D_2 and confirmed the inadequacy of an elastic, hard-sphere model for nonreactive collisions at high energies. (auth)

32216 PHOTO-INDUCED LABELLING OF ROSE BENGAL WITH ^{131}I BY ULTRA-VIOLET RADIATION. Hallaba, E.; Raieh, M. (Atomic Energy Establishment, Cairo). Int. J. Appl. Radiat. Isotop., 18: 533-5(July 1967).

Labelling techniques based on ionization and excitation in the gaseous phase suggested that labelling of Rose Bengal with iodine-131 in an aqueous medium might be achieved successfully by uv radiation. In this way Rose Bengal containing radioactive ^{131}I was obtained with a 70% yield and of 99% radiochemical purity using a very easy technique. (UK)

32217 LABELLING OF OIL BY COLLOIDAL ^{198}Au FOR TRACER STUDIES. Donhoffer, D. K.; Duftschmid, K. E. (Reaktorzentrum Seibersdorf, Austria). Int. J. Appl. Radiat. Isotop., 18: 541-2(July 1967).

For many industrial applications ^{198}Au is a very useful tracer. In connection with lubrication studies or investigations concerned with oil transport a suitable chemical form must be used, homogeneously miscible with the oil under investigation. High specific activity is necessary when very small amounts of oil have to be detected. A simple method of preparing colloidal gold from reactor irradiated $HAuCl_4$ is described, together with its incorporation into oils. Stability tests were conducted for sedimentation, deposition from oil to metal surfaces, and thermal stability. The colloidal gold is a very suitable tracer for all kinds of oil and other complex organic compounds with relatively high viscosity. (UK)

32218 REACTIONS OF HOT ATOMS OF ^{35}S IN MIXTURES OF CS_2–CCl_4 ADSORBED ON ZEOLITES. Shvedchikov, A. P. Radiokhimiya, 9: 274-5(1967). (In Russian).

It was shown that during the irradiation of CS_2–CCl_4 mixtures, adsorbed on silica gel and zeolites 4A, 5A, and 13X, the comparative yield of the labeled carbon disulfide depends on the type of adsorbent and increase by 10 to 15 times during irradiation in the zeolites 4A and 13X. The comparative yields of the labeled carbon disulfide depends on the composition of the irradiated mixture both in the presence and absence of adsorbents, reaching a minimum value at equimolecular concentration of the components. (tr-auth)

32219 REACTIONS OF ATOMS OF ^{35}S IN THE CCl_4–CYCLOHEXANE SYSTEM. II. FORMATION OF LABELED CYCLOHEXYLMERCAPTAN AND PENTAMETHYLENE SULFIDE. Dzantiev, B. G.; Shvedchikov, A. P. Radiokhimiya, 9: 276-8 (1967). (In Russian).

The reactions in the introduction and replacement of ^{35}S atoms in cyclohexane molecules during irradiation of liquid CCl_4–cyclohexane systems with thermal neutrons were investigated. The yields of labeled cyclohexylmercaptan and pentamethylene sulfide were very changeable with the composition, attaining a maximum value (3 and 8%, respectively) at equimolecular ratios of the mixture components. A possible mechanism for the formation of the labeled products is shown. (tr-auth)

32220 THE ROLE OF AUGER PROCESSES AND ELECTRON SHAKE-OFF IN THE CHEMICAL CONSEQUENCES OF RADIOACTIVE DECAY. Carlson, T. A. (Oak Ridge National Lab., Tenn.). Nippon Genshiryoku Gakkaishi, 9: 259-66(May 1967). (In Japanese).

Studies on the chemical consequences of electronic excitation resulting from nuclear processes such as β decay, positron decay, and electron capture are reviewed. There are two principal sources of electron excitation available from nuclear decay: electron shake-off and Auger processes. Decayed atoms resulting from these nuclear processes aquire a wide variety of positive charges, and can be analyzed by means of charge spectrometers. Recent studies on various gaseous systems, which contributed to elucidation of the mechanisms of initial processes in recoil chemistry are reviewed. Of interest are the experiments in which the initial electron vacancy in the inner shell of an atom was produced by x-irradiation. Some biological phenomena can also be interpreted in terms of the initial electron vacancy and of the following Auger processes. (auth)

Separation Processes

Refer also to abstracts 32126, 32139, 32172, 32176, 32177, 32183, 32348, 32349, and 33963.

32221 (BNWL-389) SPENT REACTOR FUEL: REPROCESSING REQUIREMENT, ISOTOPE CONTENT, AND TRANSPORTATION. Wilfert, G. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1967. Contract AT(45-1)-1830. 63p. Dep. CFSTI.

The annual rate of spent fuel throughput for each of four sectors of the United States and the associated isotope production for the years 1959 through 1990 are estimated. Also projected is the annual spent fuel throughput rate for the rest of the free world during 1971, 1976, and 1991. Methods of transporting the spent fuel and the costs of shipping are analyzed. Finally, the impact of sector throughput and transportation to Hanford is reviewed in connection with present commercial reprocessing capabilities. (auth)

32222 (CEA-BIB-91) LOIS DE L'ECOULEMENT DES GAZ A TRAVERS LES MILIEUX POREUX. (Laws Governing the Flow of Gases Through Porous Media). Soubbaramayer (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1967. 42p. (In French). Dep.

Methods of calculating the rate of flow of a gas through a porous media are reviewed. The porous material can be replaced either by a "capillary" model either by a "bed of spheres" model. In the capillary model the theory is derived using simple kinetic theory of gases while in the bed of spheres model one solves the BOLTZMAN equation by the random walk approach or by the well known CHAPMAN–ENSKOG expansion method. (auth)

32223 (CLOR-62/D) ANION EXCHANGE BEHAVIOUR OF ALKALINE EARTH ELEMENTS IN DIOXANE–WATER–HYDROCHLORIC ACID AND DIOXANE–WATER–PERCHLORIC ACID MEDIA. Czosnowska, W. (Centralne Laboratorium Ochrony Radiologiczne), Warsaw (Poland)). 1967. 12p. Dep.

The uptake of strontium and calcium into the strongly basic anion exchange resin Dowex-1 from dioxane–water–hydrochloric acid and from dioxane–water–perchloric acid media was measured. In contrast to the high uptake from HCl-containing media only very low uptake was observed for $HClO_4$-containing systems. A correlation between alkaline earth uptake and uptake of water and acid was found. (auth)

32224 (EUR-3473.f) RECUPERATION DU CAESIUM 137 PAR PRECIPITATION DE PHOSPHOTUNGSTATE. (Recuperating ^{137}Cs by Phosphotungstate Precipitation). Lefevre, J.; Aubertin, C. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1967. 29p. (In French). Dep.

The full process is described, as tested on inactive synthetic

fission products in a semi-industrial scale pilot plant equipped with a centrifuging settler. The process was laboratory-developed with the aid of radioactive tracers, and was designed to afford the maximum restriction of cesium waste in the effluents. With this object a certain number of internal recyclings and an initial decontamination stage were planned and tested, and these admit a waste of value in the effluents of less than 10^{-4} of the treated cesium. (auth)

32225 (EURAEC-1858) REPROCESSING OF IRRADIATED FUELS: CRITICALITY CALCULATIONS. Special Report No. 7. Servais, F.; De Myttenaere, P. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Apr. 1967. Contracts 006-65-67-RCIB-RD; 016-65-1-RAPB. 26p. (EUR-3363). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Criticality problems are among the most important faced by facilities reprocessing irradiated fuel elements. A survey, taking as its framework the reprocessing of irradiated fuel elements from a fast 1000 MW(e) reactor by a volatilization process, is presented. Criticality calculations, mostly based on the diffusion theory, were carried out on a spherical geometry of a lagged chemical reprocessing reactor containing a mixture of varying mass and proportions of fluidized alumina and plutonium tetrafluoride or dioxide. The aim of the survey was to determine the maximum number of irradiated assemblies that can be processed simultaneously by fluorination. (auth)

32226 (K-1713) REMOVAL OF IMPURITIES FROM URANIUM HEXAFLUORIDE BY SELECTIVE SORPTION TECHNIQUES. Progress Report for 1966. Stephenson, M. J.; Merriman, J. R.; Kaufman, H. L. (Oak Ridge Gaseous Diffusion Plant, Tenn.). July 17, 1967. Contract W-7405-eng-26. 55p. Dep. CFSTI.

An experimental program at the Oak Ridge Gaseous Diffusion Plant to test various solid sorbent materials to determine their effectiveness for selectively removing volatile impurities from uranium hexafluoride is reported. The testing procedure currently used involves passing a uranium hexafluoride vapor stream, spiked with one or more impurity fluorides, through a 3-inch-diameter trap containing a 36-inch-deep sorbent bed. Sample pairs are periodically withdrawn at the trap inlet and outlet and are subsequently analyzed for impurity concentrations to establish sorbent performance. The beds are also removed and analyzed following the tests to provide saturation values and data for material balance checks. In the recent test series, most of the runs were conducted using various combinations of the impurities, niobium pentafluoride, titanium tetrafluoride, ruthenium pentafluoride, tantalum pentafluoride, and antimony pentafluoride, and the sorbents, sodium fluoride at 650°F and magnesium fluoride at 250°F. The results of these simulated process sorption tests were encouraging. Magnesium fluoride could selectively remove significant quantities of niobium pentafluoride, tantalum pentafluoride, titanium tetrafluoride, and antimony pentafluoride but was less effective than sodium fluoride for removing ruthenium pentafluoride. Scoping studies designed to evaluate new sorbents were also begun, and results obtained to date indicate that lithium fluoride and aluminum fluoride are particularly promising. (auth)

32227 (LA-3698) THE PREPARATION OF ^{17}O ENRICHED WATER FROM ENRICHED NITRIC OXIDE GAS. Pavone, Daniel; Alei, Mohammed Jr. (Los Alamos Scientific Lab., N. Mex.). Apr. 5, 1967. Contract W-7405-eng-36. 6p. Dep. CFSTI.

A process and equipment designed to produce water enriched in oxygen-17 and oxygen-18 isotopes from correspondingly enriched nitric oxide gas is described. Approximately 1450 ml of high purity enriched water containing 1 to 3% oxygen-17 and 10 to 20% oxygen-18 have been produced for use primarily in nuclear magnetic resonance experimentation. Substantial quantities of nitrogen enriched in nitrogen-15 have been recovered as a by-product. (auth)

32228 (ORNL-TM-1849) FLUORIDE VOLATILITY PROCESSING SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING NOVEMBER 30, 1966. Milford, R. P.; Cathers, G. I.; Horton, R. W.; Carr, W. H. (Oak Ridge National Lab., Tenn.). July 1967. Contract W-7405-eng-26. 81p. Dep. CFSTI.

Laboratory- and small-engineering-scale studies were made in support of the fluidized-bed volatility method for recovering low-enrichment UO_2 clad in Zircaloy-2. The volatility process proposed for these fuels uses a sequence of HCl to remove the Zircaloy cladding, oxidation of the exposed UO_2 with air to form U_3O_8, fluorination with BrF_3 to form volatile UF_6, and then treatment with fluorine to produce PuF_6. All these steps and the pyrohydrolysis of $ZrCl_4$ to ZrO_2 are performed at elevated temperatures in fluidized alumina. The design of the head-end portion of the pilot plant is well advanced, and many of the major head-end items of equipment are already fabricated. The installation of structural steel, shielding, and the process off-gas scrubber system is under way in cell 3. The design of the uranium product separation and purification equipment is continuing. (auth)

32229 CONVENIENT RADIOACTIVE HALF-LIFE EXPERIMENT. Golden, J. (Enfield Coll. of Technology, Middlesex, Eng.); Maddock, A. G. Educ. Chem., 4: 178-82(July 1967).

A training experiment involves the separation of ^{234}Th from ^{238}U by carrier precipitation of the thorium with ferric iron in a uranium solution complexed by sodium carbonate. The activity of the precipitate is followed by source mounting or liquid counting techniques. The activity of the "milked" carbonate solution can also be followed to show the growth of ^{234}Th. The half-life of ^{234}Th is, however, too long for convenience (24.1 days). In the experiment described the strong beta radiation from ^{234m}Pa (half-life 1.175 min.), the short-lived daughter of ^{234}Th, is measured, since this nuclide is in secular equilibrium with the ^{234}Th. The $^{234}Pa/^{234m}Pa$ branching ratio is $0.18 \pm 0.02\%$. Solvent extraction with diisopropyl ketone is employed to separate the ^{234}Pa from the ^{234}Th preparation. A closed regenerative system is used, in which only Pa is extracted from an aqueous uranyl solution into the ketonic solvent. The decay of ^{234m}Pa is followed by directing a detector towards the solvent layer. (UK)

32230 REVERSED-PHASE THIN-LAYER CHROMATOGRAPHY OF METAL IONS WITH TRIBUTYL PHOSPHATE. Bark, L. S.; Duncan, G.; Graham, R. J. T. (Univ. of Salford, Eng.). Analyst, 92: 347-57(June 1967).

About sixty-five metal-containing ionic species were chromatographed on thin layers of cellulose impregnated with tributyl phosphate (TBP) at various concentrations of aqueous hydrochloric acid. A mechanism for the chromatography is given in terms of the ability of the metal ions to form chloro complexes; those metal ions which readily complex with chloride ion are readily extracted by the TBP and consequently have low R_F values. Conversely, those metals which do not form chloro complexes are not retained by the TBP and hence have high R_F values. Attention is drawn to the similarities between the known liquid-liquid extraction behavior of the metal ions in the TBP-hydrochloric acid systems and the behavior of these ions in the TBP-hydrochloric acid chromatographic systems. A strong resemblance has also been found between the R_F spectra (R_F versus hydrochloric acid) of the metal ions and the behavior of these ions in resinous anion exchange-hydrochloric acid systems. The latter similarity has been used as evidence for the suggestion that the TBP on the layers functions as a liquid anion exchanger, i.e., that TBP-solvated protons, ion-associated with chloride ions, can undergo ion exchange with the metal chloro complex — $(TBP)_o + (HCl)_{aq} \rightleftharpoons (TBPH^+Cl^-)_o$; $n(TBPH^+Cl^-)_o + (MCl_x^{-n}) \rightleftharpoons MCl_x^{-n}(TBPH^+)_{no} + (nCl^-)_{aq}$. The suffix o refers to the organic phase and the suffix aq refers to the aqueous phase. (auth)

32231 NUCLEAR CHARACTERISTICS OF THE EQUIPMENT OF THE KARLSRUHE REPROCESSING PLANT. Issel, W.; Schueller, W. Kerntechnik, 9: 238-42(June 1967). (In German).

The purpose and technical basis of the Karlsruhe reprocessing plant (WAK) are discussed. A survey of the unit operations and equipment to be utilized in the plant is given. Due to the processing of radioactive, radiotoxic, and fissile materials, the building layout and process equipment of a reprocessing plant must satisfy a number of requirements. Of special concern are the reliability of equipment and components, ease of maintenance, and the prevention of nuclear accidents. These subjects are discussed in more detail on the basis of specific examples from WAK process equipment. (auth)

32232 FAST EXTRACTION IN FUEL PROCESSING. Kaba, E. L. (Gelsenkirchener Bergwerks-Aktien-Gesellschaft, Essen). Kerntechnik, 9: 253-8(June 1967). (In German).

Several procedures for fuel reprocessing were investigated but only solvent extraction was proved on industrial scale. Although several alternatives of this method were elaborated, the solutions did not result in optimizing the aqueous procedure. The experiments with so-called fast extractors show a tendency according to which fast extraction in a continuous operation should be able to result in optimizing the solvent procedure. Fast extraction in nuclear engineering offers considerable technical and economical advantages and has good prospects in the future. (auth)

32233 THE NEW WINDSCALE SEPARATION PLANT, DESIGN AND EXPERIENCE. Warner, B. F. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). Kerntechnik, 9: 249-52(June 1967).

The large reprocessing plant at Windscale Works, built to process fuel from the British and Overseas Nuclear Power Programmes, is described and the general operating experience given. (auth)

32234 DEVELOPMENT AND TESTING OF A FUEL-ROD CHOPPER FOR A REPROCESSING PLANT. Dluzniewski, E.; Walther, H. J. Kerntechnik, 9: 246-8(June 1967). (In German).

For the Karlsruhe reprocessing plant (WAK), which uses a chop-leach head-end process, a chopper was designed and tested. The device was constructed for chopping single fuel rods after they were separated from fuel elements. Limitations concerned with hot-cell service were considered. The rod diameters ranged from 8 to 14 mm, the length from 300 to 4000 mm. Their cutting strength was equal to or higher than that for irradiated rods. The cutting characteristics, the cutting capacity, and the edge-life were satisfactory. (auth)

32235 DESIGN OF AND EXPERIMENTS WITH PILOT MIXER-SETTLERS FOR THE KARLSRUHE REPROCESSING PLANT. Geier, H.; Knorre, U. v. (Lurgi Gesellschaft fuer Waerme- und Chemotechnik mbH, Frankfurt am Main). Kerntechnik, 9: 243-5(June 1967). (In German).

Mixer-settlers of plexiglass were designed as models for the layout of the extractors for the Karlsruhe reprocessing plant WAK in order to study their function in normal scale. Whereas the dimensions of the settlers are simply fixed by settling experiments and scaled up by similarity considerations, experiments in normal scale are necessary to get adequate mixing for an effective design of the extraction part of a reprocessing plant. (auth)

32236 RECOVERY OF RADIOACTIVE CESIUM FROM REPROCESSING SOLUTIONS BY MEANS OF AN INORGANIC ION-EXCHANGER. Balon, G.; Beaudet, C. A.; Piret, J.; Ruston, W. R. (Societe d'Etudes de Recherches et d'Applications pour l'Industrie, Brussels). Kerntechnik, 9: 258-61(June 1967). (In German).

The physical properties and the ion-exchange capacities of tin phosphate and of titanium phosphate are presented. It is shown that tin phosphate selectively adsorbs cesium ions from strongly acid solutions and therefore makes possible the separation of ^{137}Cs from radioactive reprocessing solutions of spent nuclear fuel elements. The adsorption and elution yields obtained in a series of experiments with titanium phosphate showed that this inorganic ion exchanger can be used for an industrial process. (auth)

32237 SCANDIUM GENERATOR. Greene, M. W.; Hillman, M. (Brookhaven National Lab., Upton, N. Y.). Int. J. Appl. Radiat. Isotop., 18: 540-1(July 1967). (BNL-10940).

Scandium-44 (3.9h) is a positron emitter (1.47 MeV) with potential use as a scanning tool in medical and biological research. The short half-life of ^{44}Sc, and the long half-life of its parent ^{44}Ti (46y), make this pair of nuclides very useful in a milking system. Details are given for the separation of the scandium from the titanium by an ion exchange procedure, with a mixture of oxalic and hydrochloric acids as eluting agent. (UK)

32238 SOLVENT EXTRACTION OF METAL IONS WITH MIXED LIGANDS. VI. EXTRACTION OF In(III) AND Eu(III) WITH MIXTURES OF THENOYLTRIFLUOROACETONE (TTA) AND β-ISOPROPYLTROPOLONE (IPT). Sekine, T.; Dyrssen, D. (Royal Inst. of Tech., Stockholm. Univ. of Goteborg). J. Inorg. Nucl. Chem., 29: 1489-98(June 1967).

Solvent extraction of In(III) and Eu(III) was studied at 25°C in perchlorate media with mixtures of 4,4,4 trifluoro-1-(2-thienyl)-1,3-butanedione (TTA = HA) and 2-isopropyl-2,4,6-cycloheptatrien-1-one) (IPT = HB) in chloroform. The distribution of In(III) into chloroform was explained by the extraction of $InA_aB_{3-a}(0 \leq a \leq 3)$ complexes (type A). The mixed complexes of Eu(III) in chloroform were considered to be $EuA_aB_bH_{a+b-3}$ (type B), but the addition of 1M tributyl phosphate (TBP = L) changed the species to $EuA_aB_{3-a}L_2$ complexes (type C). Equilibrium constants were calculated for types A and C, and it was concluded that the stabilities of the mixed complexes, MA_2B and MAB_2, are almost the same as those statistically calculated. Constants were calculated for the equilibria of type B only when $[HA]_{org}$ was kept at 0.1M where the main species were considered to be adducts between EuA_3 and HB. These constants appear to indicate that IPT in the undissociated form, HB, is a rather strong donor to the EuA_3 chelate. (auth)

32239 DISTRIBUTION OF URANIUM(VI) AND THORIUM BETWEEN ALKALI NITRATE SOLUTIONS AND 5 VOL PERCENT TRI-N-BUTYL PHOSPHATE-KEROSENE. Kaiser, G.; Merz, E. (Kernforschungsanlage, Juelich, Ger.). Z. Anal. Chem., 229: 81-9(1967). (In German).

The salting-out action of alkali nitrates in TBP-extractions was studied. The uranium(VI) distribution coefficients were determined for 5 vol % TBP-kerosene as function of the concentration of sodium nitrate and potassium nitrate, respectively, and/or nitric acid, as well as for the temperature dependence. In addition, the influence of variable amounts of sodium nitrate and nitric acid on the thorium distribution coefficient as well as for the U/Th-separation factor was studied at a constant nitrate concentration of 5 mole per liter. (auth)

32240 THIN-LAYER CHROMATOGRAPHY OF THE RARE EARTHS. Massart, D. L.; Sainte, G.; Hoste, J. (Ghent Univ.). Acta Chim. Acad. Sci. Hung., 52: 229-34(1967).

A method for the separation of the rare earths is described using bis(2-ethylhexyl) ester of orthophosphoric acid and thin-layer chromatography (TLC). Every possible pair of adjacent rare earths and up to five adjacent rare earths can be separated by the method. A disadvantage of TLC is the lack of reproducibility. The method may be used for the preparation of carrier-free rare earth isotopes. (D.H.M.)

32241 SOLVENT EXTRACTION OF METAL IONS WITH MIXED LIGANDS. III. ADDUCT FORMATION OF Eu(III) AND Th(IV) CHELATES WITH TTA AND IPT. Sekine, T.; Dyrssen, D. (Royal Inst. of Tech., Stockholm. Univ. of Goteborg, Sweden). J. Inorg. Nucl. Chem., 29: 1457-73(June 1967).

Adduct formation by Eu(III) and Th(IV) chelate complexes of 2-thenoyltrifluoroacetone (TTA) and β-isopropyltropolone (IPT) with tributyl phosphate (TBP) and methyl isobutyl ketone (hexone) was studied by the distribution method using chloroform and carbon tetrachloride as organic solvents. The distribution curves show that aqueous chelate complexes are formed in most cases. In the extraction of Eu(III) with TTA and IPT the formation of an adduct with the undissociated chelating acid was observed at high ligand concentrations - $M^{3+}(aq) + 4\,HA(org) \rightleftharpoons MA_3HA(org) + 3\,H^+(aq)$ where HA denotes chelating acid. In most cases an increase in the metal extraction was observed when TBP or hexone was added to the organic solvent and this effect, which is especially large for the TTA chelates, could be explained by the formation of adducts - $MA_N(org) + nL(org) \rightleftharpoons MA_NL_n(org)$ where L denotes the neutral, adduct-forming ligand. The overall adduct formation constants were determined graphically. The formation constants were larger for the Eu(III) chelates than for the Th(IV) chelates, and larger for TBP than hexone; they were also larger in CCl_4 than in $CHCl_3$. (auth)

32242 SOLVENT EXTRACTION OF METAL IONS WITH MIXED LIGANDS. V. ADDUCT FORMATION OF SOME TRIS-TTA COMPLEXES. Sekine, T.; Dyrssen, D. (Royal Inst. of Tech., Stockholm. Univ. of Goteborg, Sweden). J. Inorg. Nucl. Chem., 29: 1481-7(June 1967).

The adduct formation of the tris-TTA complexes of In^{3+}, Sc^{3+}, La^{3+}, Eu^{3+}, Lu^{3+}, and Am^{3+} ions were studied by liquid-liquid distribution. The following equilibrium constants for the distribution and adduct formation were determined at 25°C: $M^{3+}(aq) + 3HA(org) \rightleftharpoons MA_3(org) + 3H^+(aq)$; K_{ex} $MA_3(org) + nL(org) \rightleftharpoons MA_3L_n(org)$; β_n where the chelating acid, HA, is 2-thenoyltrifluoroacetone (TTA), and the neutral ligands, L, are tributyl phosphate (TBP), dibutyl sulfoxide (DBSO) and methyl isobutyl ketone (hexone). The organic solvent was carbon tetrachloride and the aqueous phase was 1M (H,Na)ClO_4. The values of K_{ex} and β_n are tabulated. InA_3 does not form adducts. ScA_3 adds one TBP but no hexone. LaA_3, EuA_3, LuA_3, and AmA_3 add two molecules of TBP, forming adducts that are more stable than the ScA_3 adduct. The formation constants of the $MA_3(TBP)_2$ adducts showed an order of stability $LaA_3 > EuA_3 \simeq LuA_3$. DBSO gives similar results to TBP, but the adducts with hexone are less stable than those with TBP. (auth)

32243 PHOSPHATE GLASS PROCESS FOR DISPOSAL OF HIGH LEVEL RADIOACTIVE WASTES. Tuthill, E. J.; Weth, G. G.; Emma, L. C.; Strickland, Gerald; Hatch, L. P. (Brookhaven National Lab., Upton, N. Y.). Ind. Eng. Chem., Process Design Develop., 6: 314-21(July 1967). (BNL-10313).

Two years continuous operation of the Brookhaven (BNL) phosphate-glass process for disposal of high-level radioactive wastes is reviewed. A feed solution, prepared by the addition of orthophosphoric acid to raw waste, is reduced in volume by the evaporation of water and nitric acid; then on heating to 1200°C in a platinum crucible, the remaining volatile material is driven off and the concentrate is converted to molten glass. A pilot plant has processed simulated reactor waste, which would have originated from 57 tons of uranium in reprocessed fuel. A full-scale demonstration prototype plant now being constructed at BNL is scheduled for operation with radioactive fuel wastes in 1967. (auth)

32244 LARGE SCALE PROCESSING OF HIGHLY IRRADIATED PLUTONIUM BY SOLVENT EXTRACTION AND ION EXCHANGE. Eargle, J. C.; Swindell, C. W.; Martens, R. I. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Ind. Eng. Chem., Process Design Develop., 6: 348-53(July 1967). (DPSPU-65-30-29; CONF-650902-8).

Irradiated target assemblies were dissolved in nitric acid, and the resultant feed was clarified by centrifugation to remove undissolved solids. Plutonium was separated from aluminum, fission

products, and transplutonium elements either by two cycles of continuous solvent extraction or by two to four stages of anion exchange. Recovered plutonium was concentrated by ion exchange, precipitated, and calcined to the oxide. In two of five programs, americium and curium were also recovered in a nitrate solution after partial separation from fission products by precipitation as sulfates or batch solvent extraction. Performance of both solvent extraction and ion exchange during five programs was excellent, with 96% or more of the plutonium recovered from the feed. Fission-product radioactivity was reduced to a level that permitted further handling of the plutonium product in an unshielded facility. Problems with incomplete dissolution and feed adjustment were successfully overcome. (auth)

32245 INFLUENCE OF THE FIXED IONS OF ANION-EXCHANGE RESINS ON THE ADSORPTION OF METAL COMPLEXES. Wolf, F.; Neigenfind, G. (Martin-Luther-Univ., Halle, Ger.). Kernenergie, 10: 122-7(Apr. 1967). (In German).

The partition coefficients of anionic complexes of Zn, Cu, U, Fe in HCl, H_2SO_4, or NaCl solutions were studied for some strongly basic anion-exchange resins having different lengths of the amine chain. It is shown that the partition coefficients increase with growing length of the amine chain. An interpretation of this fact is given. (auth)

32246 SEPARATION OF B ISOTOPES ON BASIS OF ISOTOPIC EXCHANGE REACTION BETWEEN BF_3 AND BF_3-PHENETOLE COMPLEX. Katal'nikov, S. G.; Paramonov, R. M.; Nedzvetskii, V. S. At. Energ. (USSR), 22: 297-302(Apr. 1967). (In Russian).

Thermal dissociation of the complex of BF_3 with phenetole was investigated in the temperature range from 172 to 182°C. At water concentrations not exceeding 0.1 to 0.02% the thermal dissociation was sufficient for obtaining highly concentrated ^{10}B. The effect of the addition of phenol, also forming a complex with BF_3, on thermal dissociation of the complex was investigated. In a laboratory column 0.94 m in height and with a diameter of 16 mm tests were made on the separation of B isotopes. The values for maximum theoretical plates at 15, 25, and 35°C were calculated on the basis of the degree of separation in the stationary state. Results of tests on the laboratory column confirmed data on the thermal dissociation obtained with analog simulations. (tr-auth)

32247 SOLIDIFICATION OF HIGH-LEVEL RADIOACTIVE WASTES. PART 2. BASALT AS THE FAVORABLE INCORPORATION AND FIXATION MEDIUM. Saidl, J.; Ralkova, J. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Kernenergie, 10: 128-31(Apr. 1967). (In German).

Silicate glasses showed good properties, especially high chemical resistance, for fixation of high-level radioactive wastes. From detailed investigations on the silicate materials it was found basalts have essential advantages compared with conventional glass. After thermal treatment, the basalts are transformed from the vitreous state into the recrystallized one. Due to this recrystallization, physical and chemical changes occurred resulting in the improvement of the chemical resistivity, mechanical strength, hardness, etc. (auth)

32248 AMALGAM METHOD OF SEPARATION OF EUROPIUM FROM LANTHANUM, CERIUM, PRASEODYMIUM, AND NEODYMIUM. Cayun, M. G.; Timofeeva, T. G. Radiokhimiya, 9: 261-3(1967). (In Russian).

By use of ^{152}Eu, an amalgam method for the separation of Eu from La, Ce, Pr, and Nd with control of the potential was studied. The effects of temperature and current density on the efficiency of the separation are explained. A hypothesis on the possible formation in the mercuric phase of intermetallic compounds of Eu with cerium metals was developed. (tr-auth)

32249 POLONIUM CONCENTRATION IN BISMUTH BY A ZONE-MELTING METHOD. Konovalov, E. E.; Peizulaev, Sh. I.; Emel'yanov, V. P. Radiokhimiya, 9: 215-21(1967). (In Russian).

The distribution of polonium after zone melting of thermal-neutron-irradiated metallic bismuth was studied in relation to the rate of movement of the zones and the number of zone passes. The effective coefficients of the distribution of polonium during the zone melting of bismuth were determined for different crystallization rates and the value of the equilibrium coefficient of the distribution of polonium in bismuth was calculated. A method for the calculation of the optimum regime of the zone melting process during the concentration of polonium in bismuth was given. (tr-auth)

32250 USE OF ORGANIC COPRECIPITATIONS FOR CONCENTRATION OF ACTINIDE ELEMENTS. Akimova, T. G. Radiokhimiya, 9: 206-15(1967). (In Russian).

A review is given of organic coprecipitant used for the concentration of actinide elements. (tr-auth)

32251 RAPID CONTINUOUS SEPARATION OF THE III AND IV GROUPS OF TRANSITION ELEMENTS BY USING CHLORIDES. Zvara, I.; Zvarova, T. S.; Tsaletka, R.; Chuburkov, Yu. T.; Shalaevskii, M. R. Radiokhimiya, 9: 231-9(1967). (In Russian).

Vapors of $ZrCl_4$ and $NbCl_5$ under certain conditions appear to be an effective carrier for V, Nb, Sn, and Hf atoms, i.e., elements forming a chloride of greater volatility than the indicated chloride carriers. Under these conditions the atoms of elements having comparatively low-volatility chlorides (Na, Sc, lanthanides) precipitate on the walls. The precipitation rate shows that diffusion of the chloride molecules of these elements takes place by turbulent flow on walls where possibly irreversible adsorption occurs. The chemical behavior of $^{175,171}Hf$ during interaction with KCl in the presence of chloride carriers confirmed the hypothesis that atoms of the extracted Hf form $HfCl_4$ molecules regularly with the carrier. A method for direct determination of the transfer rate by using the long-lived isotope was proposed. Under actual conditions, a continuous highly efficient method for the extraction of Hf isotopes from nuclear reaction products was developed. The time necessary for the extraction of Hf was less than 0.4 sec and the coefficient of purification from lanthanide elements was not less than 100. It was shown that very high purification coefficients can be attained. The method presents a complete model for the chemical identification of hafnium atoms. (tr-auth)

32252 SELECTIVE CATION-EXCHANGE SEPARATION OF COBALT IN HYDROCHLORIC ACID–ACETONE SOLUTIONS. Korkisch, Johann; Gross, Harald (Univ. of Vienna). Separ. Sci., 2: 169-76(1967).

A method is described for the selective separation of Co from 29 metal ions. This technique is based on the uptake of Co together with several other metal ions on Dowex 50, X8, a strong acid cation-exchange resin, from a solution consisting of 80% acetone and 20% 3N HCl. After this adsorption, which is accompanied by the simultaneous removal of many elements, the Co is eluted with 90% acetone–10% 6N HCl. The only element that passes into the eluate together with Co in Mn(II). This method can be successfully employed to separate milligram and microgram amounts of Co from large quantities of other metal ions, e.g., Fe, Ni, Al, U, etc. (auth)

32253 COMBINED ION EXCHANGE–SOLVENT EXTRACTION OF METAL IONS ON ION-EXCHANGE PAPERS. Sherma, Joseph (Lafayette Coll., Easton, Pa.). Separ. Sci., 2: 177-85(1967).

The chromatographic behavior of 14 metal ions with aqueous-organic wash liquids on ion-exchange papers is compared with results in columns and thin layers of the same resin. It is shown that many column separations can be obtained on paper, and that paper chromatography can often be used to preevaluate systems for separations on columns. The mechanism for the chromatographic processes and differences between techniques employed with columns and papers are discussed. (auth)

32254 PRODUCTS OF THE REACTION BETWEEN ALCOHOLS AND PHOSPHORUS PENTOXIDE. I. IDENTITY AND EXTRACTANT EFFICIENCY OF THE VARIOUS PRODUCTS. Zangen, M.; Marcus, Y.; Bergmann, E. D. (Soreq Nuclear Research Center, Yavne, Israel. Hebrew Univ., Jerusalem). Separ. Sci., 2: 187-97(1967).

The product of the reaction P_4O_{10} + 4ROH, where R is an alkyl radical, is known as a powerful and selective extraction agent. It was found to be a mixture of ortho-, pyro-, tri-, and trimetaphosphate esters, produced by alcoholysis of two-thirds of all the P–O–P bonds in phosphorus pentoxide. The solvent properties for U(IV) in phosphoric acid of the various isolated compounds were found to be greatly inferior to those of the mixture, but in a few cases the combination of two compounds yielded distribution ratios comparable to those obtained with the total mixture. It may, therefore, be concluded that the extractant properties of such mixtures is due to synergistic effects. (auth)

32255 SEPARATION OF URANIUM FROM RARE EARTH ELEMENTS ON SULFONIC CATION EXCHANGER KU-2. II. OXALATE METHODS. Krawczyk-Obojska, Irena (Inst. of Nuclear Research, Warsaw). Chem. Anal. (Warsaw), 12: 225-31(1967). (In Polish).

A method was worked out for analytical separation of uranium (VI) and the rare earth elements (III). The method is based on differences between their behavior in oxalic acid solutions: the lanthanides can be selectively adsorbed on the sulfonic cation exchange resin KU-2. The Dolar and Draganic method for separation of uranium and lanthanides was tested and modified. (auth)

32256 ABSORPTION OF U(VI) FROM NATURAL WATERS AND CARBONATE SOLUTIONS BY CATION EXCHANGE RESINS. Dement'ev, V. S. Radiokhimiya, 9: 156-61(1967). (In Russian).

The absorption of uranium from natural waters and carbonate solutions using cation exchange resins was investigated as a function of the pH, carbonate concentration, ion strength of the solution, and m/V. It was shown that from water and solutions in which the uranium appears in known anion form, the absorption of uranium on the cation exchange resin can reach significant values. Under constant ion strength and m/V the percent sorption of uranium from solutions with various pH and different concentrations of carbonate approaches some general boundary. The higher the pH and the concentration of carbonate, the slower equilibrium is attained. It was assumed that the marked regularities of the ion exchange behavior of uranium is connected with the displacement of equilibrium, determining the relation between the different forms of the occurrence of uranium in solution. (tr-auth)

32257 INVESTIGATION OF THE EFFECT OF TRI-n-BUTYL PHOSPHATE AND N-OCTANOL ON THE THERMODYNAMIC ACTIVITY OF DI-n-BUTYLPHOSPHORIC ACID IN BENZENE AND n-HEPTANE IN RELATION TO THEIR ANTAGONISTIC REACTION IN METAL EXTRACTION. Mikhailov, V. A.; Grigor'eva, E. F.; Kharchenko, S. K. Radiokhimiya, 9: 149-56(1967). (In Russian).

The effect of the addition of TBP and n-octanol on the thermodynamic activity of DBP in dilute solutions with benzene and n-heptane was investigated. TBP and especially n-octanol strongly reduced the thermodynamic activity. Data on the reduction of the activity of DBP under the influence of the antagonist B was used to calculate the equilibrium constant $H_2A_2 + B \rightleftharpoons H_2A_2 \cdot B$ and $\frac{1}{2}H_2A_2 + B \rightleftharpoons HA \cdot B$. It was shown that the antagonistic effect of the additions of TBP and n-octanol during the extraction with DBP of indicator quantities of In, Y, and Lu from hydrochloric acid solution was determined principally by the drop of the thermodynamic activity of the extractant. (tr-auth)

32258 THE ISOLATION OF ^{105}Rh FROM NEUTRON IRRADIATED RUTHENIUM. Kobayashi, Y. (Japan Atomic Energy Research Inst., Tokyo). J. Inorg. Nucl. Chem., 29: 1374-6 (May 1967).

Purified Ru metals were irradiated for 20 min with a neutron flux of 1×10^{13} n/cm^2 per sec. It was dissolved in a sodium hypochlorite solution and the ruthenium tetroxide produced was completely removed from the aqueous solution by extraction using carbon tetrachloride. To isolate ^{105}Rh from the aqueous solution, ferric ions were used as a carrier; $Fe(OH)_3$ was precipitated. The $Fe(OH)_3$ was dissolved in 9M HCl and $FeCl_3$ extracted into isopropyl ether, while the ^{105}Rh was left in the aqueous solution almost carrier-free. (M.C.G.)

32259 INTERFACE MECHANISM FOR URANIUM EXTRACTION BY AMINE SULPHATE. McDowell, W. J.; Coleman, C. F. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 29: 1325-43(May 1967). (ORNL-P-2680).

In the extraction of metal ions by organic solutions of aqueous-insoluble alkyl ammonium salts, the mechanism by which the metal species transfers across the aqueous-organic interface cannot be determined by the usual equilibrium studies. In an effort to elucidate this mechanism, interfacial tension of the two-phase system and kinetics of the transfer of $^{35}SO_4$ between organic (di-n-decylamine sulphate in benzene) and aqueous (acid-sodium sulphate) phases were studied. The kinetic experiments were designed to offer the possibility of detecting the transfer of anionic uranium species from aqueous to organic phase. Several different aqueous phase conditions were examined, covering the range from low sulphate where most of the U exists as the uranyl ion to 1.0 M sulphate where most of the uranium exists as the disulphate complex. At the higher aqueous sulphate concentrations (>0.025 M) an increased rate of ^{35}S transfer during U extraction (at a given organic/aqueous total SO_4 ratio) gave strong evidence for an anion exchange mechanism such as $3(R_2NH_2)_2SO_4 + UO_2(SO_4)_2^{2-} \rightleftharpoons (R_2NH_2)_6UO_2(SO_4)_4 + SO_4^{2-}$. At aqueous SO_4 concentrations below 0.01 M, the ^{35}S transfer rate decreased during U extraction, and the explanation offered for this result suggests transfer by a neutral mechanism such as $3(R_2NH_2)_2SO_4 + UO_2SO_4$ [or $UO_2^{2+} + SO_4^{2-}$] $\rightleftharpoons$ $(R_2NH_2)UO_2(SO_4)_4$. Thus, it appears that neutral species transfer is possible where aqueous neutral or cationic species predominate and anionic species transfer is possible where aqueous anionic species predominate, with no implication that the two mechanisms are mutually exclusive. These conclusions are supported by calculations of the number of SO_4's transferred per U based on ^{35}S transfer aq → org during U transfer aq → org. (auth)

32260 SOLVENT EXTRACTION OF METAL IONS WITH MIXED LIGANDS. IV. EXTRACTION OF Eu(III) WITH CHELATING ACIDS AND NEUTRAL ADDUCT-FORMING LIGANDS. Sedkine, T.; Dyrssen, D. (Royal Inst. of Tech., Stockholm. Univ. of Goeteborg, Sweden). J. Inorg. Nucl. Chem., 29: 1475-80(June 1967).

The distribution of Eu(III) was studied with various mixtures of ligands, and the results are described. The addition of 0.1 M tributylphosphate (TBP) shifted the distribution ratio of Eu(III) between chloroform with various chelating acids and 0.1 M (H,Na)-ClO_4. The shifts (given as log DD_0^{-1}) for the different chelating acids were: 2-thenoyltrifluoroacetone (+3.4), 1-naphthoic acid (+1.1), β-isopropyltropolone (+0.5), 5,7-dichloro-oxin (+0.4), N-benzoylphenylhydroxylamine (no shift), dioctylphosphate (–0.3) and N-2,4-dichlorobenzoylphenylhydroxylamine (–0.4). The extraction of the europium(III)–TTA chelate into chloroform and carbon tetrachloride was increased by the addition of the following ligands: trioctylphosphine oxide > tributylphosphate > quinoline > coumarin > hexone > α-naphthol. The adduct formation constants for EuA_3L and in some cases EuA_3L_2 were obtained graphically and are summarized. The formation constants were larger in carbon tetrachloride than in chloroform. An increase in the distribution of Eu(III) was also observed by the addition of other chelating acids to 0.1 M TTA in chloroform. (auth)

32261 EFFECT OF β-DIKETONE STRUCTURE ON THE SYNERGISTIC EXTRACTION OF URANYL ION BY TRIBUTYL-PHOSPHATE. Batzar, K.; Goldberg, D. E.; Newman, L. (Brooklyn Coll. of the City Univ. of New York, N. Y.). J. Inorg. Nucl. Chem., 29: 1511-18(June 1967). (BNL-10494).

A study was made of the synergistic effect of tributyl phosphate on the solvent extraction of uranium by a series of β-diketones consisting of furoyltrifluoroacetone, thenoyltrifluoroacetone, benzoyltrifluoroacetone, thenoylacetone, acetylacetone, benzoylacetone, dibenzoylmethane, and thenoyltrifluoro(methyl)acetone. The stoichiometry of the reactions in these systems may be represented by $UO_2^{2+} + 2HT = UO_2T_2 + 2H^+$ and $UO_2^{2+} + 2HT + S = UO_2T_2S + 2H^+$, where HT represents the β-diketone and S the synergist, tributyl phosphate. The charged species are in the aqueous phase (2 M $LiClO_4$) and the uncharged in the organic (benzene). Synergism was observed with each of the β-diketones and the effect appeared to be related to the functional groups only insofar as the groups affected the acidity of the β-diketones. Equilibrium constants were obtained for the reactions with each of the β-diketones. A semiquantitative method for the prediction of these constants is presented. (auth)

32262 MODEL INVESTIGATION FOR ELECTROPHORETIC SEPARATION OF CARRIER-FREE RARE EARTHS. I. Grass, F.; Aitzetmueller, K.; Buchtela, K. (Oesterreichische Hochschule, Vienna). Z. Anal. Chem., 228: 261-6(1967). (In German).

The electrophoresis of rare earths on Cellogel in α-hydroxyisobutyric acid was found to be suitable for the separation of minute amounts of carrier-free activities from neutron-activated rare earths. This was demonstrated by a separation of promethium from neutron-activated neodymium, in which the purity of the separated activities was determined by their γ spectra. (auth)

32263 RARE EARTH INDUSTRY. Callow, R. J. Oxford, Pergamon Press, 1966, 84p, 10s.

A brief description is given of the rare earth elements and their sources, their extraction from ores, separation of the individual elements, development of the rare earth industry, and uses of products. (UK)

EARTH SCIENCES

Geology

Refer also to abstracts 32095, 32347, 32350–32352, 33074, 33075, and 33077.

32264 (AECL-2697) DEUTERIUM CONTENT OF CANADIAN WATERS. I. A COLLECTION OF DATA AVAILABLE AS OF FEBRUARY 1967. Brown, R. M.; Stevens, W. H.; Thurston, W. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr. 1967. 23p. Dep. CFSTI. CAN $1.00.

Data on the deuterium content of Canadian waters are assembled. These consist of results of analyses done at CRNL over the past four years on one hundred and forty surface water samples from various locations, values reported by Friedman, Redfield, Schoen and Harris (U. S. Geological Survey) for surface waters within the Great Lakes drainage basin, and data for precipitation at several northern locations obtained by W. Dansgaard (University of Copenhagen). A bibliography on natural deuterium concentrations and hydrogen-deuterium fractionation phenomena in nature is included. (auth)

32265 (IFA-MR-27) DETERMINATION OF THE UNDERGROUND WATERS FLOWING DIRECTION BY THE SINGLE WELL METHOD. Dinescu, L.; Gaspar, E.; Oncescu, M. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1967. 15p. Dep.

A tracer technique for determining the flow direction of underground water is presented. The single well method is used in which a small quantity of radioactive tracer is injected into a borehole which is crossing an aquiferous layer. The tracer is carried away by the water and contaminates the surrounding medium, which is used for detection comparisons. The maximum of the contamination is deposited in the direction of flowing current, and the measurements performed by means of Geiger-Mueller and scintillation detectors provide the means of determining the flowing direction of the underground water at the respective point. (D.C.C.)

32266 RADIOMETRIC TECHNIQUES IN PROSPECTING FOR AND EXTRACTING COAL AND ORE. Florkowski, T. (International Atomic Energy Agency, Vienna). Atomwirt., Atomtech., 12: 247-54(May 1967). (In German).

Radiometric techniques developed over the last twenty years have proved useful in prospecting for metal ores and coal and in extracting the products. They are used in borehole measurements for quantitative and qualitative geological prospecting and also in the exploitation of ores and coal. In borehole prospecting the measuring techniques may be classified as follows: gamma measurements of the natural gamma radiation; gamma–gamma measurements of scattered radiation which is excited by gamma sources; neutron measurement techniques in which either the gamma rays emitted by neutron capture or thermalization are measured. The spectroscopy of the neutron capture gamma radiation has attained great significance in the chemical analysis of minerals. In this connection activation analysis is a promising method for the determination of elementary composition. Portable equipment for determining composition of metal ores at mine sites by measuring the intensity of characteristic x-radiation excited by radioisotropic x-ray sources. These radiation sources use a soft gamma radiation on x-radiation produced by k-capture. Bremsstrahlung sources are also used. Gas proportional counters are used as detectors. The equipment mentioned for one analysis is intended for tin, zinc, iron, and copper ones. These applications are described in detail. In addition radiometric methods for the determination of the ash content of coal are also treated. (auth)

32267 DATING RESULTS OBTAINED BY COUNTING OF RADIOCARBON IN LIQUID SCINTILLATION. Dupain-Klerkx, L.; Leclipteur, J. (Univ., Liege). Bull. Soc. Roy. Sci. Liege, 36: 38-9(1967). (In French).

The development of a device during previous studies permits a routine dating by radiocarbon in liquid scintillation. The following recently obtained results are discussed: as supposed, the age of glacial wood from the Vosges Lorraines province was determined as 1,790 ± 100 years; wood carbon from a prehistoric tomb at Sanga, Congo, 9,140 ± 320 years; wood coming from Hautes Fagnes, 1,290 ± 110 years; and intercalated vegetation soils from Mount Etna, 23,225 ± 1,036 years. The calculation of the age and of its precision was made by IBM-7040. (tr-auth)

32268 THE STRONTIUM GEOCHEMISTRY OF CARBONATES IN KIMBERLITES AND LIMESTONES FROM RILEY COUNTY, KANSAS. Brookins, Douglas G. (Kansas State Univ., Manhattan). Earth Planet. Sci. Lett., 2: 235-40(May 1967).

Kimberlites containing possible primary (carbonatitic) carbonates intrude Permian limestones and shales in Riley County, Kansas. Four types of carbonates were investigated for their Sr isotope ratios and total Sr contents. The carbonate types recognized are post-emplacement veins; local limestones; pre-emplacement (possible primary carbonate) veins; and replacement and interstitial carbonates. The average $^{87}Sr/^{86}Sr$ measurements were 0.7086, 0.7081, 0.7038, and 0.7060, respectively. The average total Sr contents (in ppM) were 304, 338, 4280, and 982, respectively. These data suggest derivation of post-emplacement veins from the local country rocks, a probable original carbonatitic source for the pre-emplacement veins, and a mixture of carbonatitic and sedimentary carbonates for the interstitial and replacement material. (auth)

32269 ISOTOPIC ANOMALIES OF KRYPTON AND XENON IN CANYON DIABLO GRAPHITE. Alexander, E. C. Jr.; Manuel, O. K. (Univ. of Missouri, Rolla). Earth Planet. Sci. Lett., 2: 220-4(May 1967).

The abundance and isotopic composition of xenon and krypton have been determined in Canyon Diablo graphite. Large excesses of ^{80}Kr, ^{82}Kr and ^{128}Xe are attributed to neutron capture on bromine and iodine. The graphite contains one of the largest excesses of ^{129}Xe observed in meteoritic xenon. The xenon spectra do not display the "general anomaly pattern" which characterizes xenon in chondrites. (auth)

32270 AMAZON AND MISSISSIPPI RIVER CONCENTRATIONS OF URANIUM, THORIUM, AND RADIUM ISOTOPES. Moore, Willard S. (State Univ. of New York, Stony Brook). Earth Planet. Sci. Lett., 2: 231-4(May 1967). (NYO-3629-12).

Concentrations of uranium and thorium series isotopes were measured in two large samples of river water and associated sediment. From these data an oceanic residence time for uranium of 4 million years is calculated. The concentration of ^{232}Th in these rivers is an order of magnitude greater than in surface Atlantic waters. The amounts of ^{230}Th and ^{226}Ra being supplied to the ocean directly from rivers are less than 4% of that coming from other sources. (auth)

32271 BERYLLIUM-10 IN A MANGANESE NODULE. Somayajulu, B. L. K. (Univ. of California, San Diego, La Jolla). Science, 156: 1219-20(June 2, 1967).

Analyses of Be-10 activity in two sections of a manganese nodule indicate an accumulation rate that compares well with such rates measured by other methods on different nodules. The observed specific activity of Be-10 in the nodule is in accord with calculations based on production by cosmic rays in the atmosphere and with the geochemistry of beryllium in the ocean. (auth)

32272 ISOTOPIC COMPOSITION OF MINERAL WATERS. Konopac, J. (Vyzkumny Ustav pro Fyziatrii, Balneologii, a Klimatologii, Marianske Lazne, Czech.). Fysiat. Reumatol. Vestn. (Prague), 44: 157-63(June 1966). (In Czech).

The distribution of D in natural waters, its physiological effects, and methods for its determination are discussed. Results were obtained by measurements of D content by mass spectrometry in 39 different mineral waters of Czechoslovakian spas and bottling plants. In 24 samples the deuterium content was found to be within the range of ±2% of the deuterium content in the standard, the surface water of the Vltava River. In 9 samples it varied up to ±4%, and in 6 samples the deuterium content was found to vary as much as +5.8% to −5.7% from the standard. The ratio of the D-enriched and depleted samples was ~1:1. In thermal, sulfuric, and carbonic waters no characteristic differences in D content were noted. (BBB)

32273 GROUND-WATER AGES AND FLOW RATES BY THE ^{14}C METHOD. Pearson, Frederick Joseph Jr. Austin, Univ. of Texas, 1966. 105p.

Thesis.

A method for direct determination of ground-water ages and flow rates has been developed, based on the carbon-14 content of the carbonate dissolved in the water. This carbonate is from the CO_2 of the soil air, from limestone in the soil or in the aquifer, and, in some cases, magmatic, petroleum- or plant-derived CO_2 introduced in the aquifer. Soil air CO_2 is derived from plant respiration and decay, and its carbon isotope composition should be equivalent to that of plants. Limestone and CO_2 from the aquifer will contain no carbon-14 because of their age and will dilute the datable, soil-air-derived carbon. To determine true water age, the measured carbon-14 content must be corrected for this dilution. Water samples from wells in the Eocene Carrizo Sand in Atascosa and adjacent counties, Texas, have been dated by this

method. The ages of the water samples ranged from 0 to 27,000 years from the outcrop to 35 miles downdip, and no carbon isotope exchange could be detected. Water velocities before aquifer development based on the dates decrease away from the outcrop until, at distances of 30 miles and greater, they are stable at 5.2 ± 0.1 ft/yr. Flow rates calculated from available hydrologic data are in agreement with the carbon-14 results. (TSS) (Disser. Abstr.)

Meteorology

Refer also to abstract 32663.

32274 (COO-1407-15) RAIN SCAVENGING STUDIES, Progress Report No. 3. Dingle, A. Nelson; Gatz, Donald F. (Michigan Univ., Ann Arbor. Dept. of Meteorology and Oceanography). May 1967. Contract AT(11-1)-1407. 46p. Dep. CFSTI.

The development of an efficient data-recording and data-reduction system designed to use ¼-in. magnetic tape and to be processed by means of the analog-digital hybrid computer facility of the Department of Meteorology and Oceanography is described. A second developmental effort was the launching of pilot experiments in the use of controlled tracers for the study of severe storms circulation systems and the processes of rain scavenging. Development of a mobile sampling system suitable for use in the tracer experiments as well as in other field projects working on precipitation was a third developmental activity of the year. Details of the chemical and radiochemical procedures for the evaluation of tracer material ($^{115}In + {}_0n' \rightarrow {}^{116m}In$) were also worked out prior to the beginning of the field experiment phase May 1 to June 15, 1967. (auth)

32275 (AEC-tr-6719, pp 105-8) GEOGRAPHY OF NUCLEAR REACTOR SITES. Gudkov, A. N.; Kolobashkin, V. M.; Nekrasov, V. I.; Ushakova, N. P. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

The pollution of the atmosphere with radioactive gases and aerosols from nuclear reactors is described. The growth of nuclear power reactors for the period 1951 to 1967 is shown graphically. Virtually all nuclear power plants are concentrated in the northern hemisphere. (R.C.K.)

32276 RADIOACTIVE FALLOUT IN VILNIUS IN 1962 AND 1964. Garbalyauskas, Ch. A.; Gedeonov, L. I.; Styro, B. I.; Yakovleva, G. V. At. Energ. (USSR), 22: 302-5(Apr. 1967). (In Russian).

Data on the concentration of ^{141}Ce, ^{144}Ce, ^{95}Zr, ^{137}Cs, and ^{90}Sr in the radioactive fallout in Vilnius in 1962 to 1965 were reported. The secondary fractionation of these fission products in the radioactive fallout and their accumulation in the soil were examined. Tests were made to establish the correlation between the size of the fallout and some meteorological factors. (tr-auth)

32277 LOW-ALTITUDE INPUT OF ARTIFICIAL RADIOACTIVITY TO A SEVERE CONVECTIVE STORM: COMPARISON WITH DEPOSITION. Gatz, Donald F. (Univ. of Michigan, Ann Arbor). Contracts AT(11-1)-1370; AT(11-1)-1407. J. Appl. Meteorol., 6: 530-5(June 1967).

Concentrations of artificial radioactivity and plant pollens in rain vary in phase during convective storms. Comprehensive mesometeorological and radiochemical data collected from a segment of the severe squall line in central Oklahoma on 10 May 1964 were used in the analysis. The radioactivity inflow rate below 650 mb was estimated kinematically using serial soundings in the storm inflow and the concentration of radioactivity in ground-level air. Total input was computed by multiplying the inflow rate by the time required for the storm to cross a network of 10 ground-level rain samplers. Comparison of inflow and deposition over the sampler network shows that inflow of airborne radioactivity to the storm at low altitudes can account for artificial radioactivity deposited in the rain. (auth)

32278 THE MAXIMA OF SUTTON'S EQUATION CORRECTED FOR DEPOSITION. Milman, Y.; Tadmor, J. (Soreq Nuclear Research Center, Yavne, Israel). Health Phys., 13: 739-42 (July 1967).

In the design of a stack for the release of a pollutant, it is generally considered that an increase in the height of release helps minimize the concentration of the pollutant in the environment. In the study described it is shown that when depletion of the pollutant from the cloud by deposition during its travel from the point of release to a given distance is taken into account, the distance of maximum concentration is displaced nearer to the source as compared with the distance which maximizes Sutton's equation without considering deposition. Equations for heights of release and distances from point of release which maximize the concentration are derived, and a few numerical examples are presented. (auth)

32279 FISSION-PRODUCT PRECIPITATION FROM THE ATMOSPHERE IN DEBRECEN, HUNGARY, BETWEEN 1963 AND 1965. Szalay, A.; Kovach, A. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung., 23: 137-44 (1967).

In the period investigated, most of the radioactive fallout originated from nuclear tests carried out in 1962, though the presence of fission products of previous origin could also be demonstrated. Since the cessation of atmospheric nuclear tests the activity of rainwater decreased again in 1965 to a low level similar to that obtained in 1961, the average decontamination half period being the same as determined in our earlier works. Fission products from the nuclear test on October 16, 1964, could be detected in the Debrecen rainwater by the significant increase of specific activity on October 25 and November 18, 1964, the detectability of the October 25 being caused by tropospheric transport. The effect of the second test carried out on May 14, 1965, could not be detected. (auth)

32280 SENSITIVITY OF ENVIRONMENTAL SURVEYS TO ATMOSPHERIC RELEASES FROM NUCLEAR FACILITIES. Pelletier, Charles Alfred. Ann Arbor, Mich., Univ. of Michigan, 1966. 165p.

Thesis.

The sensitivity of an environmental survey is expressed in terms of the minimum detectable release rate MDR. The MDR is defined as that release rate which produces a radioactivity level which is just detectable above background in the environment. A method of determining the radioactivity level which is just detectable above background is discussed. The method is based on the confidence interval of the difference between the average radioactivity level near a facility and the level in an area remote from the facility, both levels being measured simultaneously, the latter serving as background for the former. The method is applied to data collected as part of the environmental survey for the Enrico Fermi Atomic Power Plant. The data include measurements of gross beta radioactivity in air, external gamma radiation exposure and gross beta radioactivity deposited on precipitation collectors. A mathematical model is developed which relates the stack release rates of iodine-131, noble gases and particulate radioactivity to their respective environmental levels. Meteorological data collected at the Fermi site are used as inputs to the model. It is found that the minimum detectable radioactivity level MDL is proportional to the background level in the environment $\bar{x}_b$, i.e., MDL = G $\bar{x}_b$. In the case of airborne particulate radioactivity the average value of G is found to be about 0.3 for one or two week sampling periods. For sampling periods of one year, the value of G is found to be reduced to about 0.1. Values of G for the other sample media are given and the dependence of G on several sources of variation in an environmental survey is discussed. The MDR is directly proportional to the MDL, i.e., MDR = [1/R(Q = 1)] MDL where R(Q = 1) is an average radioactivity level produced by a unit release rate from the facility. The value of R(Q = 1) for particulate radioactivity is found to be about 7×10^{-14} μCi/cc per μCi/sec for the air sampler near the Fermi Plant. Values of R(Q = 1) for releases of noble gases and iodine-131 are also given. The applicability of the methods and results to other locations is discussed. (Disser. Abstr.)

Mineralogy

32281 (AEC-tr-6850) STATIC LEACHING OF SPANISH URANIUM ORES. Cordero, G.; Gasos, P.; Merino, J. L.; Suarez, E. Translated from a paper presented at the International Atomic Energy Agency's Working Group on the Processing of Low Content Uranium Ores, Vienna, June 27-July 1, 1966. 30p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

A review is made of Spanish experience after seven years of work with the static leaching of uranium ores. A great diversity of minerals has been studied, both from the point of view of uranium grade (250 and 2000 ppM) and of the type of minerals and ores (granites, shales, sandstone, sulfides, carbonates, limonites, etc.). The scale of the studies has also varied considerably, ranging from a few kilograms to several tons. Different leaching agents have been used: water, solid reagents (pyrites), alkaline carbonates and sulfuric acid. The systems used range from simple set-ups to more elaborate ones with liquid recirculation. The uranium was initially recovered from the liquids by direct precipitation, but later, ion exchange technique and extraction with amines were eventually used. (auth)

32282 (AEC-tr-6851) SPANISH RADIOACTIVE LIGNITES: URANIUM NATURE AND SOLUBILIZATION. Josa, J. M.; Merino, J. L.; Villoria, A. Translated from a paper presented

at the International Atomic Energy Agency's Panel on Low Grade Uranium Ore Processing, Vienna, June 27–July 1, 1966. 20p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The characteristics of some 70 samples of radioactive lignites from different parts of Spain (Huesca, Lerida, Teruel, Galicia and Murcia) with uranium grades ranging from 20 to 1200 ppM are presented. The uranium in these minerals has been recovered by direct treatment and also after elimination of organic matter and enrichment by roasting. The uranium was leached in an acid medium, using agitation as well as static bed techniques. The influence of the following variables was studied: grain size, amount of acid, temperature, time, oxidizing agent and variations in the roasting process. (auth)

32283 CONDITIONS OF URANIUM ACCUMULATION BY PEATS. Lopatkina, A. P. Geokhimiya, No. 6, 708–19(June 1967). (In Russian).

A substantial part of uranium in waters of humid regions is present in an unstable state and may be precipitated by peats. The peat composition, the uranium content in waters, and the general mineralization of the waters influence the uranium concentration in peat. No more than 20×10^{-4}% of uranium accumulates in peats at the expense of average contents in rocks amounting to 1 to 3×10^{-4}%. (auth)

32284 THE CALAB AND EBRO-SEGRE LIGNITE URANIFEROUS RIVER BASIN. Ortega, Antonio Ramirez. Energ. Nucl. (Madrid), 10: 458–64(Nov.–Dec. 1966). (In Spanish).

The geology of the Calab and Ebro-Segre River Basin is outlined in general. The completed and projected geological studies for each river basin are outlined. (J.S.R.)

Oceanography

Refer also to abstracts 32353 and 32653.

32285 (RLO–1725–96) COLUMBIA RIVER EFFECTS IN THE NORTHEAST PACIFIC. Progress Report, June 1966–May 1967. Barnes, Clifford A. (Washington Univ., Seattle. Dept. of Oceanography). June 5, 1967. Contract AT(45-1)-1725. 29p. Dep. CFSTI.

A vast amount of previously collected information was processed, compiled, and prepared in format suitable for ready reference and circulation. New and improved methods and techniques, some developed locally, have been employed in both the field program and the interpretation of results, including improvements in the applications of statistical methods, the interpretation of geological data, the use of geophysical methods in exploring the bottom and near sub-bottom, both upriver and at sea, direct measurement of particle movement near bottom, and improved methods of chemical analysis. Research was conducted on biological, chemical, geological, and physical oceanography. A list of publications and reports submitted since the institution of the RLO system of numbering is included. (F.S.)

32286 OXYGEN-18 COMPOSITION OF OCEANIC SULFATE. Lloyd, R. Michael (Shell Development Co., Houston, Tex.). Science, 156: 1228–31(June 2, 1967).

Comparison of experimental data with analyses of oceanic sulfate indicates that oceanic sulfate is not in oxygen isotope equilibrium with ocean water. Preliminary experiments suggest that the turnover of sulfate in the sulfur cycle is too rapid to allow equilibrium to be established. If this is so, the sulfur cycle must exert a significant influence on the oxygen balance of the ocean-atmosphere system. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstract 34160.

32287 NUCLEAR WEAPONS AND DISARMAMENT. Burhop, E. H. S. (World Federation of Scientific Workers, London). Sci. World, 10: No. 4, 17-20(1966).

Hazards of accidental detonation of a nuclear weapon are discussed, and efforts to reach international agreements on limiting testing and proliferation of nuclear weapons are considered. The dangers inherent in accidental detonations are exemplified by the recent crash of a bomber carrying 4 nuclear weapons at Palomares, Spain. There was no nuclear explosion but the impact spread ^{239}Pu over an area extending 100 ft from the point of impact. Hundreds of tons of soil was removed from the area for shipment to the U. S. and eventual disposal. Widespread fear of contamination made local produce unsaleable, while the price of local seafood dropped. The accident led to a ban by Spain of any more over-flights by planes carrying nuclear weapons. It has been stated that 12 accidents involving U. S. nuclear weapons have so far occurred. One is said to have occurred in England and one in North Africa. It has also been stated that 5 of the 6 interlocking safety devices were set off in a bomb jettisoned by a B-52 bomber over North Carolina. Taking account of the numbers of nuclear weapons now in commission and the chance of an accidental nuclear explosion of one of them, the chance of a nuclear explosion by accident during the 1960's has been estimated as 1 in 100. Progress on agreement to extend the nuclear test ban to include underground tests is referred to, as is a treaty on proliferation of nuclear weapons. (BBB)

Facilities and Equipment

Refer also to abstracts 32310, 32318, 32324, 32330, 32339, 32340, 32500, 33240, 33303, 33322, and 33353.

32288 (AI-66-152) EFFECTS OF A SODIUM-WATER REACTION IN A MODULAR STEAM GENERATOR, AN EXPERIMENTAL STUDY. Goodman, L. (Atomics International, Canoga Park, Calif.). Sept. 24, 1966. 88p.

An experimental study on the effects of a sodium-water reaction which might result from the sudden rupture of a tube in a sodium-heated, modular steam generator is described. The overall objective was to determine the feasibility of designing and operating a steam generator, capable of withstanding the sodium-water reaction without exposing the rest of the steam generating plant or its personnel to undue hazards. Seventeen tests were performed in a facility designed to simulate the size, the various geometries, and the operating conditions of a single module in a sodium-heated, modular steam generator. The test section was designed to handle up to 750 lb of static sodium at 675 to 1075°F, for reaction with flowing steam at 1000°F and 2400 psi, or water at 470°F and 2800 psi. The sudden failure of a tube was simulated by rapidly pressurizing a weakened tube (within the high-temperature sodium) with high-pressure steam or water, resulting in tube failure and the start of the reaction. The resulting temperatures, pressures, and structural response were measured with thermocouples, pressure transducers, and strain gages, and recorded on high-speed oscillographs. The effects of the reaction were relieved by low-pressure (125 psi) rupture discs, located at the top and bottom of the simulated steam generator module. The contents of the module were automatically discharged through relief piping to a large reaction products tank, where the remaining sodium was chemically reacted with low-pressure (90 psi) steam. The maximum recorded pressures resulting from the sudden tube failure appeared to be limited to the maximum steam or water pressure available, and related to the rupture pressure of the weakened tube. These test-section pressure maxima represent the peak of an initial, triangularly shaped pressure spike with a maximum width of <1 msec. The pressure spikes following the first were indicative of a rapidly decaying oscillation. The time-integrated effect of these pressure pulses represents a relatively low energy release, since the maximum recorded strain in the 8-in. diameter, 0.50-in. thick test section shell indicated a stress level of <8000 psi, lasting for 2 to 3 msec. After 17 tests, the test section showed no signs of consequential damage. This fact, and the apparently low-energy release due to the sodium-water reaction, form the basis of the conclusion that it is possible to design and operate a sodium-heated, modular steam generator capable of adequately withstanding the effects of a sudden tube failure. (auth)

32289 (BNL-11464) AN 8-INCH BORE 60 KILOGAUSS SUPERCONDUCTING MAGNET TEST FACILITY. Bamberger, J. A.; Mulholland, G. T.; Prodell, A. G.; Worwetz, H. A. (Brookhaven National Lab., Upton, N. Y.); Whetstone, C. N. (Air Reduction Research Lab., Murray Hill, N. J.). [1967]. 8p. (CONF-670801-4). Dep. CFSTI.

From Cryogenic Engineering Conference, Palo Alto, Calif.

A test facility consisting of an 8-in. bore 60 kG superconducting split-pair stabilized magnet is described. A 24-in. inner diameter dewar and a 240-watt 4.5°K helium refrigerator used in the facility are also described. (D.C.C.)

32290 (EUR-3178.d) UNTERSUCHUNGEN AN FILTER-MATERIALIEN AUF IHRE EIGNUNG ALS MESSFILTER ZUR BESTIMMUNG RADIOAKTIVER SCHWEBSTOFFE IN LUFT. (Studies of Filter Materials With Regard to Their Suitability for the Measurement of Radioactive Aerosols). Hasenclever, D. (Hauptverband der Gewerblichen Berufsgenossenschaften, e. V., Bonn (West Germany). Staubforschungsinstitut). May 1967. 35p. (In German). Dep.

Two main groups of filters are presented: (1) Those having an efficiency which may vary greatly depending on the inlet flow-rate for the 0.01-1 μm particle size range. Average efficiencies of above 85% are not attained in this group at the inlet flow-rates used at the stations and for aerosols of less than 0.3 μm diameter (31.5-82.6%). In the case of oil mist (0.2-1 μm diameter), however, efficiencies of 7.0 to 99.98% can be attained, depending upon the flow-rate. Using the same filter material there may be wide efficiency fluctuations from filter to filter, which create the illusion of fluctuations in the radioactive aerosol concentration. Efficiency may vary greatly with particle size. The minimum efficiencies depend upon particle size and air-velocities. (2) Filters whose efficiency for the relevant particle size range varies with the flow-velocity chosen but is always over 97%. With oil mist (0.2-1 μm diameter) their efficiency is always more than 99.7%. Even these high-efficiency filters have fairly clearly defined minima, which vary as a function of the aerosol particle size and the air-velocity. (auth)

32291 (EUR-3470.d) STUDIE EINER GENERELLEN TECHNISCHEN LOESUNG DES DATENUEBERTRAGUNGSPROBLEMS IN EINEM KERNFORSCHUNGSZENTRUM. (Study on a General Technical Solution for a Data-Transmission Problem in a Nuclear Research Center). Becker, W. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 1967. 28p. (In German). Dep.

A study of the technical feasibility of a general data communication system is presented. After a short survey of the applications of such a system in the Ispra center, the technical possibilities for executing the cable network with regard to cable type and network organization are discussed. It is proposed to use a system with a single multiple ramified coaxial cable (ORLOC-System). Such a network can only be realized for larger extension and high data flux by means of a new type of ramification points. The developed circuits avoiding attenuation and reflection at the ramification point for any sense of information flux by means of a negative resistance are treated in detail. A calculation of the obtainable data flux per subscriber as well as for the whole system, applying time multiplex organization of the ORLOC-System, is presented. The advantages of this system are considered to be its great flexibility in adapting to changing gravity points of data sources and data processing. Its further advantages are the capability of increasing the number of subscribers and changing the applied signal types. Even temporarily installed accesses to the system might be admissible from the economic point of view. (auth)

32292 (MND-3062-24) QUEHANNA RADIOISOTOPES PILOT PLANT ENGINEERING MANUAL CELL 4 PROCESS. Gaitanis, M. J.; Tripp, L. F.; Vogele, W. A. (Martin Co., Baltimore, Md. Nuclear Div.). May 1966. Contract AT-(30-1)-3062. 135p. Dep. CFSTI.

The operational procedures for the Quehanna Cell 4 Process System are presented. The hot cell facilities, processes and process control, requirements and safety limitations, Cell 4 Process Box, barriers and ventilation, the stationary overhead transfer system (SOTS), the replacement procedures for the Chamber 4A and Chamber 4B apparatus, and the dismantling procedures for the Cell 4 Process Box are described. (D.C.C.)

32293 (NAA-SR-12416) LIQUID METAL ENGINEERING CENTER (LMEC) QUARTERLY TECHNICAL PROGRESS REPORT, JANUARY-MARCH 1967. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). May 5, 1967. Contract AT(04-3)-700. 60p. Dep. CFSTI.

A review of the objectives and accomplishments of the Liquid Metal Engineering Center during the period January to March

1967 is presented. Progress is reported on the Liquid Metal Fast Breeder Reactor (LMFBR) coolant system valves, piping, and pumps; testing of intermediate heat exchangers and prototype steam generators for the Sodium Component Test Installation; evaluation of information on sodium and NaK alloys as heat transfer and transport fluids; conceptual designs of the Sodium Pump Test Facility (SPTF); testing of sodium pump bearings and seals; design fuel handling devices, control rod drives, and fuel hold-down mechanisms for the sodium-cooled fast breeder reactors; installation of the B & W steam generator in the SCTI; maintenance procedures for temporarily idle LMEC equipment; and the development of high temperature strain measurement gages. (D.C.C.)

32294 (TID-23853) SEMI-IMPLICIT NUMERICAL METHOD FOR TREATING THE TIME TRANSIENT GAS LUBRICATION EQUATION. Castelli, V.; Stevenson, Charles H. (Mechanical Technology Inc., Latham, N. Y.). Mar. 1967. Contract Nonr-3730(00). 17p. (MTI-67TR14). Dep. CFSTI.

A numerical method is presented for treating the time transient Reynolds equation which has the numerical stability properties of implicit schemes and the speed of execution of explicit methods. These advantages make this method quite suitable for both steady-state and transient calculations. (auth)

32295 (UCRL-70258(Rev.1)) CENTRAL STATION APPLICATION OF GRAPHITE HELICAL ROTOR EXPANDERS. Wells, W. M. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 28, 1967. Contract W-7405-eng-48. 11p. (CONF-670806-4). Dep. CFSTI.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla.

A preliminary examination is made of use of graphite helical rotor expanders in central station cycles similar to those proposed for inert gas nuclear MHD cycles. It is indicated that thermodynamic cycle efficiency will be better than for the MHD cycles. Graphite is currently available in the correct size range and with adequate mechanical properties. Gas bearings are indicated to be feasible for the application to central stations. (auth)

32296 STRESS CONCENTRATION AT THE JUNCTION OF AN ELLIPTICAL HEAD WITH A CONICAL PIPE. Curioni, Sergio (Comitato Nazionale per l'Energia Nucleare, Bologna). Nucl. Eng. Design, 5: 325-37(May 1967).

The stress in the vicinity of the intersection of a conical shell and a reinforced elliptical head is calculated, assuming that the nozzle is subject to internal pressure, to an axial thrust, and to a nonuniform temperature distribution across the thickness. The problem is solved analytically, working from the hypothesis that the radius of the opening is small in relation to the main axis of the ellipse. For numerical evaluation a calculation program for use on an IBM 7094 has been developed. (auth)

32297 PLUM BROOK'S CRYOGENIC IRRADIATION TEST FACILITY. Coombe, John R. (Westinghouse Astronuclear Lab., Large, Pa.). Cryog. Eng. News, 2: No. 6, 16-17; 20-2(June 1967).

Experimental apparatus and its use for cryogenic temperature effect studies on the Nuclear Engine Rocket for a Vehicle Application (NERVA) reactors in the NASA Plum Brook Reactor Facility are described. The Horizontal Through Hole No. 1 (HT-1) which serves as the experimental access to the reactor core is discussed. The water-cooled facility was used to test resistance temperature transducers, strain gages, linear displacement transducers, mechanical components, pressure transducers, accelerometers, and materials for the NERVA program. Instrumentation and materials tests are to be conducted in the cryogenic loop at maximum nominal environmental conditions of 3×10^{13} nvt E > 1 MeV, and 4.8 watts per gram at gas steam temperatures of 50°R. (D.C.C.)

32298 STRESSES IN JUNCTION OF NOZZLE TO CYLINDRICAL PRESSURE VESSEL FOR EQUAL DIAMETER OF VESSEL AND NOZZLE. Bijlaard, P. P. (Cornell Univ., Ithaca, N. Y.); Dohrmann, R. J.; Wang, I. C. Nucl. Eng. Design, 5: 349-65(May 1967).

A method was developed whereby the stresses in a juncture of a nozzle to cylindrical pressure vessel for equal diameters can be determined. The application of the proposed method includes pipelines, header nozzle junctures, process reactors, nuclear reactors, etc. In a derivation of the methods utilized to compute the stresses, the proposed shell theory takes into account the fact that the shells are thick. This fact is neglected in conventional thin shell theory. As part of the development, the shell shear deformations and the resulting stresses are considered in addition to the thick shell stress distributions caused by internal pressure loading. The solution of the three coupled partial differential shell equations is obtained through the use of a series solution that satisfies the differential equations as well as the continuity conditions at the juncture of the two shells. In addition to the theoretical development, a proposed method for the numerical solution of the equations is given. (auth)

32299 FRICTION WELDING. (to American Machine and Foundry Co.). British Patent 1,073,923. June 28, 1967. Priority date July 10, 1963, United States.

A method of friction welding workpieces of at least $1/100$ in.^{2} of either zirconium or zirconium alloy is presented. The weld is accomplished by rotating the workpieces with an average relative speed of over two fps and forcing the workpieces together so that from 3,500 to 35,000 ft-lb of energy are released per in.^{2} of weld area. A compressive force of 5,000 to 40,000 psi of weld area is applied after rotation is stopped. When welding together workpieces of zirconium and a zirconium alloy, the same rotation speed is maintained while a force of 150 to 1,500 psi of weld area is applied. Steps of rapid stopping are made from one sec to five sec while a force of 5,000 psi of weld is applied. The weld is completed in 10 sec if 3,500 ft-lb of energy are used and in less than 2 sec if between 3,500 and 35,000 ft-lb of energy are used. (D.C.C.)

32300 IMPROVEMENTS IN OR RELATING TO PUMPS FOR PUMPING LIQUIDS AND APPARATUS FOR EMBODYING SUCH PUMPS. Sanderson, Peter Robin; Steel, Robert Thomas (to Central Electricity Generating Board). British Patent 1,072,173. June 14, 1967. Filed July 21, 1965.

The design of a pump to transport a liquid slag is presented. In a magnetohydrodynamic power generator of the open cycle type which burns fossil fuel, the heat exchange medium which is circulated through the exhaust gases and then through the combustion air is referred to as "slag." To maintain the desired form of liquid drops or granules of slag in the heat exchangers at pressures above atmospheric, a pump was constructed which has one or more inlets to and one or more outlets from a central chamber. The inlets and outlets are designed to form vortexes in the liquid as it flows through the pump. The quantity of flowing liquid is controlled in the central chamber by means of injecting compresed gas to force the liquid out at desired rates. A system of nonreturn valves maintains the desired direction of liquid flow. (D.C.C.)

32301 STEREO POSITRON CAMERA FOR DETERMINING THE SPATIAL DISTRIBUTION OF RADIOACTIVE MATERIAL IN A TEST BODY. Anger, Hal O. (to U. S. Atomic Energy Commission). U. S. Patent 3,329,814. July 4, 1967.

The design of a positron camera for accurately determining the origin of radioactive emanations from within a subject by using stereo images to obtain depth perception is presented. A positron emitting radioactive material is injected into a subject and the subject is viewed by the camera. Each nuclear event results in a pair of oppositely directed gamma rays, one being detected in a large scintillation crystal viewed by photodetectors arranged to detect spatial position while the second gamma ray is detected by one of a pair of spaced apart scintillation crystals on the opposite side of the subject. Electronic coincidence circuitry is provided to analyze and separate various signals obtained and display two stereo images on an oscilloscope screen. (AEC)

32302 NEUTRON GENERATING APPARATUS. Adachi, Takeshi (to Tokyo Shibaura Electric Co. Ltd.). British Patent 1,073,646. June 28, 1967. Filed July 21, 1964.

The design of a neutron generating device is described. The neutron generator contains an ion source shielded by iron, paraffin, a water tank, and a sheet of cadmium, and an accelerating tube mounted vertically over a neutron-radiating target. The entire accelerating tube assembly is also mounted in container which serves as an evaluation device. (D.C.C.)

32303 IMPROVEMENTS IN OR RELATING TO GAGES. Sayers, John Francis (to United Kingdom Atomic Energy Authority). British Patent 1,072,511. June 21, 1967. Filed Feb. 28, 1964.

A capacitance gage is described which will measure circularity in cylindrical pellets and in a bore in relation to a reference axis. The gage consists of a body, means for centralizing and rotating the gage in relation to the bore, means for moving the gage axially through the bore, an electrode, and a means for measuring the capacitance between the electrode and the bore. In measuring the circularity of pellets, means are provided also for revolving the work pieces relative to the body. (F.S.)

32304 IRRADIATION PLANT. (to Sulzer Brothers Ltd.). British Patent 1,072,319. June 14, 1967. Priority date Apr. 13, 1964, Switzerland.

An irradiation plant is described which consists of a closed-loop chain conveyor. Two parallel runs are used so that each sample passes the radiation source four times, twice close to the

source and twice farther away from the source. The conveyor also has a control system for regulating stops for irradiation and loading and unloading the separate loads on the conveyor. (F.S.)

32305 SHIELDED ANALYTICAL FACILITY (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, S. C.). (CAPE-1602).

129 drawings.

A versatile analytical laboratory facility with two hot cells is described. The 25 by 50 foot facility was installed within the existing laboratory and consists of two intermediate-level analytical chemistry cells interconnected with a sample receiving area, an analytical laboratory, and a decontamination area. The facility provides continuous containment of contamination during all transfers to and from the cells and within the analytical laboratory from receipt of sample to completion of analysis. (For details see TID-4100 Suppl. 40.) (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 32328, 32330, and 34111.

32306 (EURAEC-1833(Pts.1 and 2)) CRITICAL STUDIES ON STEADY BURNOUT. FINAL REPORT. PART 1. CORRELATION FOR NON UNIFORM HEATING. PART 2. STUDIES ON LINEAR CORRELATIONS. Clerici, G. C.; Garriba, S.; Sala, R.; Tozzi, A. (Applicazioni e Ricerche Scientifiche, Milan (Italy)). [1967]. Contract 073-65-11-TEEI. 150p. (EUR-3356(Pts.1 and 2)). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

This report issued in two parts, but cataloged as a unit.

The parameters which influence nonuniform heating and the dependence of the critical heat flux on such parameters are presented. Correlations are presented in the form of diagrams, tables and graphs. The areas discussed include uniform and nonuniform thermal heat fluxes in simple and complex geometries. The methods for reduction of the derived correlations into the linear form by means of transformations and approximations are discussed. The numerical comparisons of the linear forms with the experimental data are also shown. (D.C.C.)

32307 (FEI-61) PREDEL'NYE ZNACHENIYA CHISEL NUSSEL'TA DLYA KOL'TSEVOGO ZAZORA. (Limiting Values of Nusselt Numbers for Ring-Shaped Gaps). Volchkov, L. G.; Kirillov, P. L. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1966. 20p. (In Russian). Dep.

A survey of data found in the scientific literature and the solutions to heat exchange problems in ring-shaped gaps for the case of plane velocity profile are presented. The limiting Nusselt (P_r = 0) numbers are given in the form of graphs for different geometrical tube parameters, heat loads, and heat flows. (D.C.C.)

32308 (GEAP-5275) A PROGRAM OF TWO-PHASE FLOW INVESTIGATION. Quarterly Report No. 14, July-September 1966. Kroeger, P. G.; Zuber, N. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Oct. 1, 1966. Contract AT(04-3)-189. 75p. (EURAEC-1765). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

In a study of the average volumetric concentration in two-phase flow through rectangular channels a model for the prediction of steady-state void fractions in two phase mixtures was developed and checked against recent experimental data for rectangular channels. It was found that the analysis can be extended and applied to predict the void fraction in rectangular ducts. Results of this comparison clearly indicate that simultaneous measurements of void and flux profiles are required to obtain further insight into the dependence of the distribution parameter C_0 on such variables as aspect ratio, flow and pressure. Experimental results show that at the pressure level of 0.65, most points for constant heat input as well as oscillating heat input tests fell into the subcooled boiling regime, where thermodynamic non-equilibrium prevailed. To determine the repeatability of void fraction measurements in this regime a series of tests was run for identical operating conditions. It was found that the local chordal void measurements are repeatable except in the region close to the tube walls. The obtained cross sectional average void fractions were repeatable within the accuracy of the test data. Those constant heat input test points which fell into the bulk boiling region are presented in a velocity-flux plane. Results confirmed the good agreement between analysis and prediction, which has previously been observed at lower pressure levels. During the oscillating tests at this pressure level it was found mandatory to take several local chordal void readings at each station and each frequency in order to obtain results of sufficient accuracy. One such test has been run at a mass flow of 620,000 lb/ft^2 hr, and the results are presented. (auth)

32309 (LA-DC-8587) HYDROGEN HEAT TRANSFER IN THE PRESENCE OF THERMAL-ACOUSTIC OSCILLATIONS. Thurston, R. S. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 23p. (CONF-670801-1). Dep. CFSTI.

From Cryogenic Engineering Conference, Palo Alto, Calif.

Oscillations having acoustic properties can be generated during forced-convection film-boiling heat transfer to liquid or dense supercritical hydrogen. Inception conditions, frequencies, and pressure amplitudes of these oscillations were correlated. An analysis of heat transfer data collected in the presence of thermal-acoustic oscillations reveals the oscillations did not affect the average rate of heat transfer to gaseous hydrogen despite recorded fluid temperatures with amplitudes up to 100°R at 10 cps. However, heat transfer to liquid and dense supercritical hydrogen improved with the approach to conditions which generated oscillations but was not affected by the intensity of oscillations. It is recommended that oscillations be monitored on heat transfer test sections and that their absence or presence be reported with heat transfer data. (auth)

32310 (MMPP-293-2) TWO-PHASE VORTEX FLOW. Lafferty, J. F.; Hammitt, F. G. (Michigan Univ., Ann Arbor. Michigan Memorial Phoenix Project). May 1967. 171p.

An investigation to determine the basic characteristics of gas-driven two-phase liquid vortex flow is described. The vortex flow of interest is characterized by a cylindrical containment chamber with injection ports in the cylindrical wall and a central exhaust port in one or both end plates. Although the gas-driven gas vortex and the liquid-driven liquid vortex are not necessarily typical of the gas-driven two phase vortex, some of the results from investigating single-phase vortices indicate the types of problems that will be encountered with the two-phase vortex. (D.C.C.)

32311 (NYO-2404-76) BOILING HEAT TRANSFER WITH ELECTRICAL FIELD (EHD). Final Report. Durfee, Robert L.; Nichols, Charles R.; Spurlock, Jack M.; Markels, M, Jr. (Atlantic Research Corp., Alexandria, Va.). Feb. 1966. Contract AT(30-1)-2404. 194p. Dep. CFSTI.

Enhancement of boiling heat transfer to isopropanol and deionized water through the application of electrical fields (electrohydrodynamics) was studied over a wide range of conditions. The work with isopropanol utilized dc voltage in both pool boiling and forced circulation systems at essentially ambient pressure. For water, 60 cps ac voltage was used with pool boiling at ambient pressure and with forced circulation at pressures ranging from ambient to 1500 psia. Mass flow rates ranged up to 0.5×10^6 lb/hr.-sq. ft. for the forced circulation work at ambient pressure, and up to 2.0×10^6 lb/hr.-sq. ft. at the higher system pressures. Steam heating was used for the ambient pressure studies, and electrical heating was used for the high-pressure work. In the pool boiling studies transfer to isopropanol was increased to a factor of six times the normal nucleate peak by application of 10,000 volts dc. The boiling mode appeared nucleate when voltages of 1,000 volts or more were applied, regardless of the temperature difference. From an analysis of the wetted area of the heater, it was found that heat transfer (at normal film boiling conditions) corresponded to an increase in wetted area up to about 1,500 volts, and to a decrease in wetted area at higher voltages. Heat transfer rates were linear with voltage at all conditions for which wetted area was not increasing as a function of voltage. The forced circulation work at ambient pressure produced results similar to those obtained with pool boiling Neither mass flow rate of coolant nor exit quality (up to four percent) exhibited any significant effect on the magnitude of the heat transfer increases due to voltage. It was demonstrated that two types of electrostatic forces (arising from dielectrophoresis and the "condenser effect") influence boiling heat transfer augmentation. (auth)

32312 (SC-CR-67-2635) A STUDY OF THE BEHAVIOR OF SMALL SPHERES DURING REENTRY. Lundberg, Raymond E.; Reynolds, William C.; Rindal, Roald A. (Aerotherm Corp., Palo Alto, Calif.). June 1967. Contract 6002-004. 99p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

The dynamic behavior during reentry of plutonium dioxide microspheres ranging in diameter between 50 and 250 microns is examined. The reentry trajectories, aerodynamic heating, and particle heating and melting are examined. The conditions for which wholly liquid droplets may shatter are examined. A method to describe the instability of a thin liquid layer on a solid substrate which experiences the complex reentry phenomena of deceleration, shear pressure and drag forces is presented. Particles of this diameter released at altitudes between 120,000 and 250,000 feet at velocities between 15,000 and 25,000 feet per sec-

ond are shown to melt and in most cases the liquid layer is calculated to be unstable. (auth)

32313 (SC-CR-67-2636) HYDRODYNAMIC STABILITY OF THE LIQUID LAYER ON A SMALL OBJECT IN HIGH ALTITUDE REENTRY. Reynolds, W. C. (Stanford Univ., Calif. Dept. of Mechanical Engineering). June 1967. Contract 6002-004. 44p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

The hydrodynamic instabilities relevant to a thin liquid layer on a small body reentering the atmosphere are reviewed. An analysis is presented for the case of a liquid layer subjected to an impinging hypersonic free molecule flow. The Craik–Benjamin instability mechanism is found to be quite important. A simplified estimate is given for the conditions under which a small body may be expected to survive reentry without melt layer removal. (auth)

32314 (UCRL-70472) PRESSURE VARIATION BETWEEN CONCENTRIC CYLINDERS AFTER RAPID HEATING OF THE INNER CYLINDER. Giedt, Warren H.; MacLean, L. M.; Clough, R. E. (California Univ., Livermore. Lawrence Radiation Lab.). May 22, 1967. Contract W-7405-eng-48. 11p. (CONF-670909-2). Dep. CFSTI.

For Presentation at Semi-International Symposium of Mechanical Engineers, Tokyo, Japan.

A study was made to assess the possible use of a system of two thin concentric cylinders for investigating interface heat transfer resistance when the contact pressure varies. The proposed technique is to discharge a capacitor bank through two contacting concentric cylinders, which are selected so that the inner one has a much lower electrical resistivity than the outer one. The inner cylinder experiencing the greater temperature rise will then expand against the outer cylinder and during the resulting transient heat transfer period the interface pressure will vary. To determine how the interface pressure would vary in such a system, the dynamic response of concentric cylinders when the inner cylinder is subjected to rapid heating was analyzed. Each cylinder was assumed to behave as a membrane and as a single thermal capacitance. The effects of internal damping and variable resistance to heat transfer between the two cylinders were included. The outer cylinder deformation was considered to be elastic. Either elastic or elastic–plastic stress-strain response of the inner cylinder was specified. Representative analytical results for cylinder systems subjected to exponential heating pulses of 100 and 2000 microseconds are presented. Interface pressures were found to rise rapidly to maximum values and then decrease as heat transfer from the inner to the outer cylinder occurs. The importance of the initial clearance between the cylinders and the use of a stress-strain relationship which accounts for plastic deformation is demonstrated. It is concluded that the proposed system would be suitable for studying thermal interface resistance with variable contact pressure. (auth)

32315 (UJV-1726) DVOUFAZOVE PROUDENI HELIA TRUBKAMI. (UJV 1726, Two-Phase Flow of Helium Through Tubes). Prusak, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Nov. 1966. 125p. (In Czech). Dep.

A theoretical treatment of the flow of mixtures of liquid and gaseous helium in tubes is presented. Such flow differs from the flow of other liquids because of the unique properties of liquid helium, e.g., its low boiling point, its low specific heat, its low critical pressure and density. The results of experiments on the flow of liquid and gaseous helium in tubes are given and are shown to agree with the results of calculation within ±10%. The implications of these results for the design of Dewars and siphons for transferring liquid helium are summarized. (TTT)

32316 (USNRDL-TR-67-49) RELATIVE MOTION AND COAGULATION OF PARTICLES IN A TURBULENT GAS. Huebsch, I. O. (Naval Radiological Defense Lab., San Francisco, Calif.). May 4, 1967. 113p.

All particles in a turbulent gas move relative to each other because of turbulent shear. Particles of different sizes also move relative to each other because of turbulent and gravitational accelerations. The theory of particle collision and coagulation due to these mechanisms and to Brownian movement is reviewed. The theory of motion relative to the fluid and of turbulent coagulation is extended to particles whose relaxation times are larger than the turbulent microscale, using turbulent similarity theory. The extension is based on the suggestion of V. G. Levich that for each such particle size there is a size of eddy relative to which particle speed is a maximum. This maximum is the peak of a resonance curve of particle speed vs eddy size, or wave length. The basic equation used is $q^3 \sim r\epsilon\rho/C_D\rho_a$ where q is maximum particle speed relative to the fluid, r is particle radius, ϵ is turbulent energy dissipation rate, ρ and ρ_a are particle and fluid densities respectively, and C_D is drag coefficient, given as a function of Reynolds number $2rq/\nu$ where ν is kinematic viscosity. The importance of different coagulation mechanisms is compared. The condition that at least for some sufficiently small particles the rate of turbulent-accelerative coagulation exceed that of gravitational coagulation is that the microscale Froude number exceed unity: $Fr_0 = v_0^2/g\lambda_0 > 1$ where v_0 is the microscale of velocity, λ_0 the Kolmogorov microscale length, and g the acceleration of gravity. A method of numerical solution of the coagulation equations is given, and tested against analytic solutions. (auth)

32317 (WAPD-TM-658) FLOW PATTERNS IN HIGH PRESSURE TWO-PHASE (STEAM-WATER) FLOW WITH HEAT ADDITION. Hosler, E. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1967. Contract AT(11-1)-Gen-14. 192p. Dep. CFSTI.

The flow patterns that occur in forced flow vaporization of water at high pressure have been observed and photographed. A vertical rectangular channel, 1/8 inch thick × 1.0 inch wide × 24 inches long, heated from one side, the other three sides being used for observation of the flow phenomena, was used for the experimental investigation. The ranges of variables covered include: pressure: 150 to 2000 psia; mass velocity: 0.10×10^6 to 4.0×10^6 lb/hr-ft^2; heat flux: up to 1.8×10^6 Btu/hr-ft^2; and quality: subcooled to 0.70. The flow patterns observed included bubble, slug-type, annular, spray-annular, and wave flow. Comparisons were made between observed flow pattern transitions and several published flow pattern maps which are generally based on adiabatic flow. The differences between two-phase adiabatic flow and two-phase flow with heat transfer are noted. An empirical flow pattern map is presented which correlates the experimental data better than the previously published maps. (auth)

32318 (WAPD-TM-669) HOT-2: A TWO-DIMENSIONAL TRANSIENT HEAT CONDUCTION PROGRAM FOR THE CDC-6600. Peterson, W. D.; Spanier, J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1967. Contract AT(11-1)-Gen-14. 279p. Dep. CFSTI.

HOT-2 is a digital computer program to solve two-dimensional plane and axially symmetric steady-state and transient heat conduction problems with diagonal boundaries and interfaces. Mesh spacing (at most 5000 points) is completely variable. As many as 99 regions are permitted in order to describe spatial variations in material properties, heat generation rates, and boundary conditions. The heat generation rate and boundary conditions may vary with time. The alternating direction iterative method is used to solve the difference equations, both for transient and steady-state calculations. (auth)

32319 DISTRIBUTION OF COOLANT AND STRESS VELOCITY ON WALL IN CLOSE PACKED RODS. Levchenko, Yu. D.; Subbotin, V. I.; Ushakov, P. A. At. Energ. (USSR), 22: 218-25 (Mar. 1967). (In Russian).

Experimental distribution of the velocity and tangential stress on the wall in turbulent flow of coolants in densely packed rods are reported. In the test it was established that in the range from 14×10^3 < Reynolds no. < 95×10^3 the distribution of the tangential stress on the wall can be independent of Reynolds no. It was shown that the distribution of the velocity perpendicular to the wall agrees well with the experimental data for round tubes. (tr-auth)

32320 TEMPERATURE AND THERMOELASTIC STRESS FIELDS IN AN INFINITE HALF-SPACE DUE TO AXISYMMETRIC SURFACE HEAT TRANSFER. PART I. ITERATIVE PERTURBATION SOLUTION OF INTEGRAL EQUATION FORMULATION. Holy, Z. J. (Univ. of New South Wales, Kensington, Australia). Nucl. Eng. Design, 5: 255-67(May 1967).

An iterative perturbation method is developed, based on an integral equation, for the solution of temperature and stress fields due to localized axisymmetric variation of the heat transfer coefficient over the surface of a heat producing infinite half-space. The method is applied to a number of heat transfer distributions of practical interest and results are plotted. Conclusions are drawn regarding the effect of various distributions on the temperatures and stresses. (auth)

32321 STUDIES ON FLUID MIXING BETWEEN SUBCHANNELS IN A BUNDLE OF FINNED TUBES. Nijsing, R.; Eifler, W.; Delfau, B.; Campositvan, J. (EURATOM, Ispra, Italy). Nucl. Eng. Design, 5: 229-53(May 1967).

A study has been made of the fluid flow behavior in a bundle of finned tubes, simulating the characteristic parts of an ORGEL cluster fuel element. Results obtained concern flow distribution and intersubchannel mixing rates. The experimental data were in good agreement with the predictions of relatively simple hydrodynamical models. (auth)

32322 THE APPLICATION OF THE CAPACITANCE METHOD FOR VOID FRACTION MEASUREMENT IN BULK BOILING CON-

DITIONS. Cimorelli, L.; Evangelisti, R. (Centro Studi Nucleari, Casaccia, Italy). Contract 024-64-4. Int. J. Heat Mass Trans., 10: 277-88(Mar. 1967).

The application of the impedance method, developed as capacitive, to the study of bulk boiling at atmospheric pressure, is described. Corresponding to two values of mass flowrate, the calibration curves void fraction vs relative capacitance are deduced, up to void fractions of about 85 to 90 percent; as a void fraction standard value the response of the dilatometric method is chosen. The differences between the experimental calibration curves and the Maxwell law are calculated and plotted. (auth)

32323 FLUID FLOW CONTROL DEVICE FOR MULTI-CONDUIT STRUCTURES. Servanty, Pierre; Rousseau, Jean-Jacques; Chaumette, Paul Joseph Adrien (to Societe Nationale d'Etude et de Construction de Moteurs d'Aviation). British Patent 1,073,453. June 28, 1967. Priority date Dec. 7, 1963, France.

The design of a transverse auxiliary jet used to control fluid flow through a conduit is described. Particular application of this control jet is the flow control of heat carrying fluids in conduits and in tubes of a nuclear reactor, especially when elements are being added or removed which affects fluid resistance, flow rates, and temperature gradients. The control jet operates externally from the tubes or conduits by using a nozzle to produce a sheet-like jet of fluid directed crosswise to the flow path of the fluid through the conduit. In this way the element can be manipulated in the conduit without serious alterations in channel fluid flow. Since the jet is external to the conduit, it can be moved to separate positions with ease, and therefore changes in conduit loadings and element positions can be made while the reactor is in operation. (D.C.C.)

Isotope Technology

Refer also to abstracts 32265, 32420, 33840, and 33960.

32324 (BNWL-381) THE DENSIFICATION AND ENCAPSULATION OF ISOTOPIC FUELS BY HIGH ENERGY PNEUMATIC IMPACTION. Final Report. Berglund, C.; Hammond, V. L.; Johnson, B. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1967. Contract AT(45-1)-1830. 74p. Dep. CFSTI.

High energy pneumatic impaction was developed as a process for the fabrication of high density, high integrity, radioactive heat sources. It was found that the capsule design (cladding wall thickness and shape), tooling lubrication, outgassing temperature, energy input, and mass of the core material were the prime variables that affected the final shape of the heat source. Capsule welding, compaction machine instrumentation, and methods of determining the energy imparted to the heat source were investigated. The fabrication of isotopic heat sources in a remote radioactive hot cell was determined to be feasible. (auth)

32325 (CONF-661203) ISOTOPE SYSTEMS DEVELOPMENT PROGRAM. Eighth Annual Contractors Meeting, December 5-7, 1966. (Division of Isotopes Development (AEC), Washington, D. C.). 89p. Dep. CFSTI.

A review of progress in the development of new principles and techniques for using isotopes is presented. Papers presented at the conference are categorized as basic information, analytical aspects, marine device development, environmental applications, industrial applications, aerospace applications, and national security applications. (D.C.C.)

32326 (COO-578P28-10) FEASIBILITY OF ISOTOPIC X-RAY SOURCES FOR PORTABLE STRESS ANALYSIS EQUIPMENT. Semmler, R. A. (IIT Research Inst., Chicago, Ill.). Apr. 1967. Contract AT(11-)-578. 80p. Dep. CFSTI.

The feasibility of using a 10 millicurie ^{55}Fe x-ray source for x-ray diffraction is examined. Diffraction lines from iron were measured to within 0.2° using a proportional counter and rudimentary apparatus, but experiments with film were unsuccessful because of the low Mn K_α photon output (10^6/sec). Further improvement in speed and resolution is possible for general diffraction work but the diffraction angles are poorly situated for stress work. Other source and film characteristics measured in the study include the angular dependence of the radiation, x-ray transmission of the Polaroid XR-7 cassette, Polaroid film sensitivity, and a comparison of intensifier screens. Suggested collimator arrangements to permit using a larger area source with less self-absorption are given. In conjunction with a smaller diffraction camera than used here, it is concluded that the present source would be adequate for a portable diffraction instrument of modest resolution for field work with either pulse counters or film. A film system would be particularly simple and highly portable. Film exposure times producing a weak but definite line would be of the order 10 hours. (auth)

32327 (MMM-3824-0006) SNAP-23A PROGRAM. PHASE I. ADVANCED TERRESTRIAL RADIOISOTOPE POWER SYSTEMS CONVERTER DEVELOPMENT PROGRAM. Quarterly Report No. 1, February 1, 1967-March 31, 1967. Schwarz, H. F. (Minnesota Mining and Mfg. Co., St. Paul. Isotope Power Lab.). May 22, 1967. Contract AT(30-1)-3824. 182p. Dep. CFSTI.

The SNAP-23A development effort toward the design, fabrication, and test of a thermoelectric converter design to be used as a component in the 60-watt SNAP-23A Terrestrial Radioisotope Power Supply System is described. Progress is reported on the 60-W converter development, based on the SNAP-23 Program baseline technology, and the thermoelectric couple improvement program, designed to incorporate material and fabrication technology improvements into thermoelectric units capable of achieving the desired 10-year life objective of the SNAP-23A. Progress is also reported on the following tasks: converter weldment stress analysis; converter support system spring rate analysis; outer case and cold frame analysis; hot frame interface analysis; thermoelectric couple design procedures; computer programming for converter performance; development of 10-couple module variables matrix; hardware design and development; and thermal analysis of 10-couple module. (D.C.C.)

32328 (MND-3607-93(Vol.2)) DISTRIBUTION OF HEAT AND PRESSURE ON THE SNAP 19 FUEL CAPSULE IN HYPERSONIC FLOW. (Martin Co., Baltimore, Md.). Mar. 1967. Contract AT(30-1)-3607. 236p. DTIE.

A compilation of data on the distribution of heat and pressure on the SNAP-19 fuel capsule in hypersonic flow is presented. The data are contained in three appendixes which show the correlation of pressure test results with shadowgraphs from force model tests, the results from the Langley Research Center hypersonic pressures digital program, and the results of the hypersonic heating rate digital program. (D.C.C.)

32329 (NP-16757) ECONOMIC FEASIBILITY OF THE USE OF LARGE RADIATION SOURCES FOR THE PRESERVATION OF POTATOES AND ONIONS. Cohen, Yigal (Economic Consulting and Planning Ltd., Tel Aviv (Israel)). Mar. 1967. 136p. Dep.

For Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center.

An economic feasibility study of radiation preservation of potatoes and onions is presented. The comparisons of cold-storage, chemical retardation, and irradiation methods of preservation are discussed. (D.C.C.)

32330 MICROELECTRONIC DEVICE FOR MEASURING HEAT TRANSFER COEFFICIENTS IN FLUIDIZED BEDS. Barker, James J. Ind. Eng. Chem., Fundam., 6: 139-42(Feb. 1967).

A fluidizable particle containing a heat source, electron current source, thermistor, and radio transmitter circuit is made of BeO and is 1 cm. in diameter. The carrier wave is 80 megacycles and the temperature-sensitive pulsing frequency is around 10 kc. per second. Heat is supplied by 16 curies of ^{210}Po. Early prototypes use Hg hearing-aid batteries, but thermoelectric devices are adaptable to later units. The device is capable of accurate measurement of the average heat transfer coefficient for a particle in a fluidized bed. Temperature differences of several degrees, between the particle and the fluidizing, atmospheric air, can be measured with estimated errors less than a few percent. The cost of developed units would be about $1150, $900 being for the heat source. (auth)

32331 THERMAL DIFFUSION IN ISOTOPIC GASEOUS MIXTURES. Vasaru, Gheorghe (Inst. for Atomic Physics, Cluj). Fortschr. Phys., 15: No. 1, 1-111(1967).

Thermal diffusion in isotopic mixtures is of interest as a process for the separation of isotopes and as a study of the phenomenon on intermolecular forces. The transport phenomenon relies on the fact that in the presence of a temperature gradient in a binary or multicomponent gaseous mixture there is a transport of matter which produces a concentration gradient where the light component of the mixture concentrates in the region of a higher temperature and the heavy component in the region of a lower temperature. When using thermal diffusion for isotopic separation, the magnitude of the elementary thermal diffusion for a certain isotopic mixture is determined by α_T, the thermal diffusion factor's value. The experimental search for the correct evaluation or most accurate evaluation of α_T is presented. (D.C.C.)

32332 ^{137}Cs LOSSES DURING INCINERATION OF FOODSTUFFS. Peter, G. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Atompraxis, 13: 192-3(Apr.-May 1967). (In German).

The temperature in foodstuffs (milk powder, flour, vegetables, and fruits) during incineration using porcelain and steel dishes has been measured. Steel dishes have been found to be more suitable for incineration of foodstuffs than porcelain dishes. Their ad-

vantages are better heat conductivity; no inflammability because the temperature in the samples increases slowly; the temperature in the sample is never higher than the temperature of the muffle furnace (400°C); and ^{137}Cs losses are not to be expected. (tr-auth)

32333 RADIOISOTOPES IN PROPELLANT AND EXPLOSIVES TECHNOLOGY. Wilkniss, P. E. (Naval Propellant Plant, Indian Head, Md.). Atompraxis, 13: 176-80(Apr.-May 1967).

Practical applications of radioisotopes to problems in propellant and explosives technology, other than propulsion purposes, are described. Examples of these applications include: radiochemical methods using tracer techniques to study the mixing, degradation, and physical chemistry of propellants; thermal and fast neutron activation analysis of explosives and propellants for improving their performance and reducing erosion; and radioisotope sources used for liquid rocket fuel leak detectors, zero gravity fuel gages, and static eliminators. (L.C.L.)

32334 IRRADIATION APPARATUS. (to Sulzer Brothers Ltd.). British Patent 1,072,074. June 14, 1967. Priority date June 1, 1964, Switzerland.

An irradiation apparatus is described which consists of a radiation source in a radiation-absorbent block, a friction roller-driven piston which extends through the block and has at least two chambers adapted to receive materials to be irradiated and which is mounted to permit the horizontal movement of the chambers into and out of the vicinity of the radiation source. (F.S.)

32335 PREPARATION OF HEAT SOURCES FOR RADIOISOTOPE HEATED THERMOELECTRIC GENERATORS. Samos, G.; Bloom, J. L. (to U. S. Atomic Energy Commission). U. S. Patent 3,330,889. July 11, 1967.

A process is presented for making strontium-90 titanate heat sources in which the pH and temperature of an aqueous solution of strontium-90 is adjusted, whereby when an organic titanate ester is added, the resulting precipitate of strontium-90 can be separated. In one embodiment the organic ester used is ethanolamine titanate. (AEC)

32336 SENSIBLE HEAT SOURCES USING FISSION PRODUCTS. Naismith, Donald Porter. Ames, Iowa, Iowa State Univ., 1966. 92p.

Thesis.

The design of a safe, long-lived device which uses the decay energy of unseparated, calcined radioactive fission products for heating a fluid such as air is presented. The heater is designed to produce a minimum of 25,000 Btu/hr at temperatures up to 300°F for a design lifetime of 30 years. The source design is based on calcined fission products (CFP) which have aged three years and have an activity of 180,000 curies per pound. The CFP are contained in seven longitudinally finned Hastelloy tubes four inches in inside diameter and three feet in length. Each tube is positioned within a vertical coolant channel. Natural convection cooling is sufficient to prevent overheating in case of an inoperative fan. The cylindrical, stainless steel clad uranium shield was selected for maximum portability, minimum weight, and minimum space. The shield thickness required for a surface dose of 200 mr/hr is 5.3 inches. Approximate overall dimensions of the heater are 31 inches in diameter and 59 inches in height. Gamma ray heating in the shield is theoretically investigated and found to be of little consequence if the inside surface of the shield is cooled by the air flow. If the coolant flow is blocked it is estimated that 11 hours are required before the shield will approach its melting point. The first-cost estimate of $0.08 per kilowatt hour indicates this source of energy is worthy of more consideration than it has previously been given. (Disser. Abstr.)

Materials Testing

Refer also to abstracts 32288, 32297, 32326, 32868, 34181, 34187, and 34188.

32337 (FFA-107) CREEP DEFORMATION AND BUCKLING OF A COLUMN WITH AN ARBITRARY CROSS SECTION. Samuelson, Ake (Flygtekniska Forsoksanstalten, Stockholm (Sweden)). Sept. 1967. 35p. Dep. SWED.

The general equations for a column with an arbitrary cross section, subject to secondary creep, were derived, using a "multiflange" model in order to take into account and to predict a non-linear stress distribution. The equations were solved numerically by means of finite difference methods. A large number of calculations were carried out in order to demonstrate the abilities and limitations of the method. The maximum deflection was found to approach large values within a short interval of time, thus defining exactly the critical time. The shape of the cross section was found to have a significant influence on the creep buckling time, and for a nonsymmetric section the direction of buckling was also of importance. Comparisons with other theories based on similar assumptions showed good agreements. The results of an experimental investigation were reported, and comparisons with the theory were carried out. Although the number of tests was rather limited, the results seemed to confirm the predictions provided by the theory. The block diagram and FORTRAN IV programs for the numerical treatment are given in the appendix. (auth)

32338 (SC-CR-67-2595) STUDY OF THE CHEMICAL INTEGRITY OF RADIOISOTOPE CONTAINMENT MATERIALS IN LAUNCH ABORT ENVIRONMENTS. PHASE III. BEHAVIOR OF GRAPHITIC MATERIALS. Gregson, W. Jr. (TRW Systems Group, Redondo Beach, Calif.). Apr. 1967. Contract 48-4912. 38p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

The study of the reactions of two commercial graphites when subjected to controlled flame environments is presented. (auth)

32339 (TID-23886) EFFECTIVE ELASTIC COEFFICIENTS FOR A SPHERICAL SHELL PERFORATED BY MANY RADIAL HOLES. Report No. 112-A. Rung, Robert; Salerno, V. L.; Mahoney, J. B. (Applied Technology Associates, Inc., Ramsey, N. J.). May 1967. Contract W-7405-eng-26; Subcontract No. 2752. 56p. Dep. CFSTI.

Explicit formulae are developed for the calculation of the eight effective stiffnesses of a spherical shell perforated by many radial holes in regular triangular or radially orthogonal patterns. The governing partial differential equations for the unsymmetrically loaded spherical shell are given. Recommendations for refinement of the analysis of the bending case are made. (auth)

32340 (WAPD-TM-398(Add.1)) SEAL-SHELL-2: A COMPUTER PROGRAM FOR THE STRESS ANALYSIS OF A THICK SHELL OF REVOLUTION WITH AXISYMMETRIC PRESSURES, TEMPERATURES, AND DISTRIBUTED LOADS. Friedrich, C. M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1967. Contract AT(11-1)-Gen-14. 15p. Dep. CFSTI.

The SEAL-SHELL-2 program determines stresses, strains, deflections, and reactions in a thick shell of revolution having axisymmetric loading. The loading consists of a temperature distribution, inside and outside pressure distributions, and circumferential forces and moments applied to the middle surface. The shell is linear-elastic with tensile, bending, and shear strains. The SEAL-SHELL-2 computer program has been modified to include an option for plotting the shape of the shell in a meridian plane with radial R and axial Z co-ordinates. The plot is generated on the CDC-280 microfilm plotter by a set of FORTRAN callable subroutines, and shows the actual shape used by the program. Another improvement is the inclusion of an option to input the influence coefficients of the flexibility matrix of any segment. The coefficients may be for any axisymmetric structure, such as a tube sheet in a heat exchanger. Another application would be to condense a group of segments into a single element which may be used in a series of problems and so cut down running time on the computer. A third application is to use the condensed group of segments as a single element in order to allow more elements in the analysis of a critical region of the shell. (auth)

32341 IMPROVEMENTS IN OR RELATING TO SEALED CONTAINERS AND TO METHODS OF AND APPARATUS FOR TESTING FOR LEAKS THEREFROM. Hayes, David John (to Central Electricity Generating Board). British Patent 1,071,794. June 14, 1967. Filed Aug. 31, 1964.

A method and the equipment used for leak testing a sealed container are described. A radioactive gas, preferably ^{85}Kr, is inserted into the container before sealing. The presence of the radioactive gas is measured with a thallium activated NaI scintillation detector. The radiation of the ^{85}Kr which penetrates the walls of the container is measured, and with the container in a chamber with reduced pressure, the radioactivity which has leaked into the chamber is measured with an organic scintillation detector. This method is applicable for automatically leak testing reactor fuel elements in which the fuel material is sealed in a can. (F.S.)

32342 IMPROVEMENTS IN OR RELATING TO TECHNIQUES FOR EXAMINING THE INTERNAL STRUCTURE OF A SPECIMEN. Aveyard, Sydney (to United Kingdom Atomic Energy Authority). British Patent 1,072,436. June 14, 1967. Filed Sept. 4, 1963.

A method is described for examining the internal structure of an electrically-conducting specimen. The specimen is scanned by a coil carrying a high frequency oscillatory electric signal which induces eddy currents in the portion of the specimen adjacent to the coil. An output electric signal which varies in dependence upon variations in the eddy currents is derived. Variations in the eddy currents are caused by variations in the resistivity of that

portion of the sample caused by the physical configuration of its internal structure. The output signal is supplied to a facsimile recorder which produces a representation of the internal structure of the specimen. This method is particularly, but not exclusively, suited to the detection of voids in sodium filled fuel elements for reactors. (F.S.)

Protective Structures

Refer also to abstract 32305.

32343 (AD-654151) SCATTERED RADIATION (SKYSHINE) CONTRIBUTION TO A CONCRETE-COVERED BASEMENT LOCATED IN A SIMULATED FALLOUT FIELD. Final Report. Schumchyk, Michael J.; Schmoke, Murray A.; Schulman, Ernest L.; Pollock, Edward O. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). July 1967. 84p. (NDL-TR-69).

The effect of overhead mass thickness on the shielding characteristics of a concrete-walled basement located in a simulated fallout field is determined and the results are compared with theoretical calculations set forth in NBS Monograph 42. A uniformly contaminated residual gamma radiation area was simulated to a radius of 600 feet with a cobalt 60 point-source circulation system. Experimental exposure-rate measurements were obtained in the free field and also within a concrete-covered basement as a function of height above the basement floor. Ionization chamber dosimeters were used as radiation detectors. Experimental measurements were extrapolated by analytical procedures to infinite field conditions and divided by the infinite free-field exposure rate measured 3 feet above ground to find the reduction factors. These reduction factors were compared with the theoretical results. Experimental results show that the theoretical formula $T = S(d = o)\, S'(X)\, S_a(d = o,\omega)$ underestimates the reduction factors. For the concrete cover thicknesses of 46, 67, and 89 psf used in this experiment, reduction factors were underestimated by 13, 16, and 11 percent, when calculated by this formula for the 6-foot, center detector locations. This underestimation of the reduction factors increased with depth in the basement to 69, 71, and 73 percent for the three cover thicknesses. The increase in underestimation of the reduction factors was caused by the geometry function $S_a(d = o,\omega)$. When the theoretical formula was modified to $R = S(d = o)S'(X)L_a(X + 34.5,\omega)$, the formula was applicable to predict the reduction factors to within 28 percent at all detector locations in a concrete-covered basement with cover thicknesses ranging from 46 to 89 psf. The USANDL experimental skyshine barrier attenuation factor agrees within ±6 percent with the theoretical skyshine barrier attenuation factor, $S'(X)$, for overhead mass thicknesses between 46 and 89 psf. (auth)

32344 (R-OU-266) RADIOLOGICAL RECOVERY REQUIREMENTS, STRUCTURES, AND OPERATIONS RESEARCH: INTRODUCTION AND SUMMARY. Final Report. Bryan, F. A. Jr. (Research Traingle Inst., Durham, N. C.). May 1967. Contract N0022866C1086. 25p.

The primary objectives of this study were to develop procedures which may be employed to estimate the effects of limited strips of contamination for the optimum direction of decontamination operations, and to develop a procedure for obtaining estimates of the protection factor available in damaged structures by means of a multiplicative function. The results of the research in these activities are summarized, and general and specific conclusions and recommendations given. (auth)

32345 (R-OU-266(Vol.1)) RADIOLOGICAL RECOVERY REQUIREMENTS, STRUCTURES, AND OPERATIONS RESEARCH. VOLUME I. CALCULATIONAL TECHNIQUE FOR DETERMINING IMPORTANCE OF LIMITED STRIP DECONTAMINATION PROCEDURES. Final Report. Doggett, W. O.; Bryan, F. A. Jr. (Research Triangle Inst., Durham, N. C.). May 1967. Contract N0022866C1086. 222p. (USNRDL-TRC-67-2).

A description of the CONSTRIP III computer program is given. This program calculates the penetration of radiation from a uniformly contaminated horizontal rectangular source area through a shielding wall to a point detector. CONSTRIP III differs from CONSTRIP II in three major respects: the detector may be located at the rear surface of the wall as viewed from the source; calculations may be performed for a zero wall thickness (no wall present); and an option to incorporate the build-up-air-attenuation factor for cobalt-60 on a concrete slab has been included. The method of summing contributions from source-patch, wall-slab combinations is the same in both programs. The program is in good agreement with hand calculations and published experimental and theoretical results, and it is an improvement over previous techniques for solution of the barrier shield problem. (auth)

32346 (R-OU-266(Vol.2)) RADIOLOGICAL RECOVERY REQUIREMENTS, STRUCTURES, AND OPERATIONS RESEARCH. VOLUME II. DAMAGED PF MULTIPLIER. Johnson, T. (Research Triangle Inst., Durham, N. C.). May 1967. Contract N0022866C1086. 43p. (USNRDL-TRC-67-4).

The theoretical development and a demonstration of a damaged protection factor multiplier are presented. A multiplier of the form $e^{B_0+B_1X_1+\cdots+B_nX_n}$ is prepared for multiplying the undamaged protection factor to obtain an estimate of the protection factor after structural damage. The X_i represent such factors as loss of exterior wall mass, ingress of fallout, and loss of interior partitions. The variables selected explain a large fraction of the change in protection factor caused by damage to a structure. Methods of testing the model are presented. (auth)

Radioactive Material Handling

Refer also to abstracts 32243 and 32292.

32347 (BNWL-412) THE EFFECTS OF BEN FRANKLIN DAM ON HANFORD. PART I. WASTE DISPOSAL FACILITIES INVESTIGATIONS. PART II. GROUND WATER FLOW SYSTEM ANALYSIS. Final Report. Haney, W. A. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1967. Contract AT(45-1)-1830. 101p. Dep. CFSTI.

The waste facility exploration phase of the Ben Franklin Dam investigation was undertaken to define concentrations of long-lived radionuclides in the vadose zone immediately above the present water table. The species and amount of radioisotopes subjected to ground-water leaching due to the elevation of the water table from the construction of the dam is defined. Thirty wells totalling 4988 feet were installed to study fifteen sites. Results show that there are no adverse effects to using the designed waste facilities. The flow system analysis phase of the Ben Franklin Dam study indicates that installation will have significant effects on the water table elevation, flow paths and travel times of the ground water. The proposed Purex plant disposal sites are, therefore, to be located near the predicted ground water stagnation point with the dam in place. (D.C.C.)

32348 (SZS-2/67) REGENERIERUNG BELADENER IONENAUSTAUSCHER BEI DER BEHANDLUNG RADIOAKTIVER ABWAESSER. I. LABORUNTERSUCHUNGEN ZUR REGENERIERUNG VON WOFATIT KPS. (Regeneration of Loaded Ion Exchangers for the Treatment of Radioactive Wastes. I. Laboratory Investigations on the Regeneration of Wofatit KPS). Bosholm, J.; Richter, D.; Lenk, M. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Mar. 1967. 32p. (In German). Dep.

The regeneration of ion exchange resins loaded by radioactive waste water is presented. In order to select the optimum conditions for the regeneration of the strong acid cation exchange resin Wofatit KPS in a pilot plant, laboratory trials were made on the regeneration capacity and on the rate of fission product removal from the resin. Best results were obtained with 2 bed volumes of 4 N nitric acid. The optimum flow rate depends on the diameter of resin particles and must be less than 15 bed volumes per hour for particle diameters from 0.16 to 0.25 mm. Under these conditions 99 per cent of the capacity was regenerated and 90 per cent of the fission product activity was eluted. The elution of residual activity by repeated use of the resin was negligible for treatment of waste water. (auth)

32349 (SZS-6/67) REGENERIERUNG BELADENER IONENAUSTAUSCHER BEI DER BEHANDLUNG RADIOAKTIVER ABWAESSER. II. LABORUNTERSUCHUNGEN ZUR REGENERIERUNG VON WOFATIT SBW UND WOFATIT SBK. (Regeneration of Loaded Ion Exchanger for the Treatment of Radioactive Waste. II. Laboratory Investigations on the Regeneration of Wofatit SBW and Wofatit SBK). Bosholm, J. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Apr. 1967. 24p. (In German). Dep.

In order to select optimum conditions for the regeneration of the strong basic anion exchange resins Wofatit SBW and Wofatit SBK in a pilot plant, laboratory investigations were performed on the regeneration capacity and on the rate of fission product removal from the resins. The parameters of operation are better for Wofatit SBK than for Wofatit SBW. Best regeneration was obtained with 3 to 4 bed volumes of 1 N caustic soda. The optimum flow rate depends upon the diameter of the resin particles and must be less than 5 bed volumes per hour for particle diameters from 0.16 to 0.25 mm. Under these conditions 95% of the capacity is regenerated and 85% of the fission product activity is eluted. (auth)

32350 (ORNL-tr-1701) WHITHER WITH "ATOMIC WASTE". Ramdohr, Harald. Translated for Oak Ridge National Lab., Tenn. from Umsch. Wiss. Tech., 67: 219-24(1967). 17p. Dep. CFSTI. JCL $1.60 fs, $0.80 m...

Methods for the disposal of radioactive wastes in the Federal Republic of Germany are presented. Due to geological and environmental restrictions in Germany, deep underground formations are being used for disposal. Methods of constructing caverns and using geologic formations in salt mines are presented. Methods of processing waste materials to be suitable for underground storage are also presented. (D.C.C.)

32351 WASTE MANAGEMENT AND ENVIRONMENTAL ASPECTS OF NUCLEAR POWER. Lieberman, Joseph A.; Belter, Walter G. (Atomic Energy Commission, Washington, D. C.). Environ. Sci. Technol., 1: 466-75(June 1967).

The processing and disposal of radioactive waste and their effects on the growth of competitive nuclear power in the U. S. are discussed. The physical, chemical, and radiometric properties, as well as abundance and origin of radioactive waste are described. Also presented are the characteristics of the media in which the waste is being disposed and the basic radiation protection standards or criteria which must be met. (D.C.C.)

32352 DISPOSAL OF WASTE RADIOACTIVE GASES IN POROUS UNDERGROUND MEDIA. Reist, Parker C. (Harvard School of Public Health, Boston). Nucl. Appl., 3: 474-80(Aug. 1967).

Underground storage as a disposal method for long-lived radioactive gases is an attractive possibility. It is estimated that radioactive gases could be disposed of underground for about $2/1000 ft^3 (atm) of waste gas. Possible problems which might arise with this type of disposal are discussed. (auth)

32353 A MODEL FOR THE APPROXIMATE CALCULATION OF SAFE RATES OF DISCHARGE OF RADIOACTIVE WASTES INTO MARINE ENVIRONMENTS. Freke, A. M. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Health Phys., 13: 743-58(July 1967).

Prior to embarking upon an extensive program of investigations into marine waste disposal, a preliminary assessment is useful to determine, approximately, the potential of the marine environment to receive a given radioactive waste. Attention is directed to identifying that return route of the disposed activity to man which is most likely to be limiting in terms of exposure to radiation, and establishing the critical radionuclide or radionuclides involved. Derived working limits for the concentration of activity in seawater for 142 radionuclides are given, based on four return routes via flesh of fish, crustacea and mollusks, and edible algae, assuming that the entire dietary protein requirement of an individual is obtained from these sources, and using generalized concentration factors for the concentration of activity from seawater to edible marine organisms. Taking account of the removal of activity by radioactive decay, the derivation of a weighted mean replacement value for a mixture of radionuclides is given. The application of these values to a determination of the number of discharges, or rate of discharge, per annum, which could be made into a given volume of receiving water, for a waste of approximately known composition and activity, is illustrated with specific examples. It is concluded that such approximations would not exceed accurately assessed values by as much as an order of magnitude and in most cases, due to inherently conservative assumptions used in the assessment, would be an order of magnitude or more lower. (auth)

32354 TRANSPORT OF THE RAW MATERIALS OF THE URANIUM INDUSTRY: ORES, CONCENTRATES, URANIUM METAL. Buret, R. Bull. Inform. Sci. Tech. (Paris), No. 115, 45-56(May 1967). (In French).

The essential aspect of the problem of transport of raw materials in the uranium industry is economic. The transportation necessary to carry out the present French program of annual uranium ore production is described. The technical means employed to transport ores, uraniferous preconcentrates produced overseas, concentrates and uranium ingots are described. The quantities in metric tons represented by this program are indicated, and an idea is given of the extent to which the transportation price contributes to the cost price of nuclear fuels. This is observed to be far from negligible. (auth)

32355 STATISTICAL AND ECONOMIC DATA OF RADIOACTIVE MATERIALS TRANSPORTATION. Labrousse, M. Bull. Inform. Sci. Tech. (Paris), No. 115, 57-70(May 1967). (In French).

The establishment of a cost price meets with many difficulties in the matter of the transport of radioactive materials. However, statistics show that the volume of these transports, which has grown very quickly since 1958, has begun to take on a more uniform aspect since 1965. We have seen that the technical and statutory problems are well defined, even if they are not all solved. The time has come therefore when evaluations and estimates of a valid order of magnitude can be made. The unit costs relative to the various means of transport, the types of packaging used, and the nuclear risk insurance are presented. A synthesis of the cost price is made for a few transports. (auth)

32356 REMOVAL OF RADIOACTIVE IODINE VAPOR WITH ION-EXCHANGER. Iwai, Sigehisa (Kyoto Univ.); Inoue, Yoriteru; Terasima, Yutaka; Sugawara, Masataka. Nippon Genshiryoku Gakkaishi, 9: 249-58(May 1967). (In Japanese).

The use of ion exchange materials for the removal of radioactive iodine from air streams is investigated. Experiments were carried out with ion exchange resin, liquid ion exchangers and other materials to evaluate the removal efficiency and factors affecting the removal. A packed column of Amberlite-IRA-400-OH showed a high exchange absorption capacity for gaseous iodine. The rate of iodine transport from air stream to resin phase and the rate of ion exchange were estimated to be sufficiently high. A larger decontamination factor for radioiodine (3.5×10^3) was obtained with the Amberlite column than with either activated charcoal, copper balls, or molecular sieves under conditions of identical pressure loss. The presence of 50% CO_2 in the air stream provided little interference with the exchange ability of Amberlite due to the large mass action constant between I^- and CO_3^-. Tris(2-ethylhexyl)amine showed smaller removal efficiency than solutions of either silver nitrate, sodium hydroxide, or sodium thiosulfate under conditions of identical volume and concentration. (auth)

32357 PROCESS FOR THE PRODUCTION OF SOLID PRODUCTS CONTAINING RADIOACTIVE WASTE MATERIAL AND PRODUCTS OBTAINED ACCORDING TO SAID PROCESS. Lefillatre, G.; Scheidhauer, J.; Rodier, J. (to Commissariat a l'Energie Atomique). Canadian Patent 754,476. Mar. 14, 1967. Priority date Dec. 6, 1961, France.

Low activity radioactive waste in the form of an aqueous paste is mixed with semi-fluid bitumen below 95°C in the presence of a wetting agent. Most of the water can then be removed by decantation or other mechanical means. Residual water is distilled off. Additional mixing with more bitumen at a temperature sufficient to allow pouring is the last step. Blocks of suitable plasticity are obtained for burial in the ground. (F.S.A.)

32358 IMPROVEMENTS IN OR RELATING TO CONTAINERS FOR TRANSPORTING RADIOACTIVE AND/OR FISSILE MATERIALS. Nash, Geoffrey James Chetewoode; Harding, Keith (to United Kingdom Atomic Energy Authority). British Patent 1,073,751. June 28, 1967. Filed Mar. 13, 1964.

The design of a radioactive material transport container is described. The inner vessel of the container which holds the radioactive material is made of aluminum. A casing surrounding the vessel is made of a neutron moderating substance and a neutron capturing substance uniformly distributed in a matrix of cast synthetic plastic material which also provides fire protection to the vessel. The mixture is designed to consist of epoxy resin and hydrated salt borax with a 1:1 weight ratio. The outer covering of the container is made of steel. In this arrangement, neutrons emitted from the fissile material inside or outside the container will be sufficiently moderated. (D.C.C.)

Vacuum Engineering

32359 (UCRL-14291) HYDROGEN ADSORPTION AND CONDENSATION IN A HELIUM CRYOPUMP. Wegmann, Glen L.; Hunt, Angus L.; Goodman, Ronald K. (California Univ., Livermore. Lawrence Radiation Lab.). May 10, 1967. Contract W-7405-eng-48. 10p. Dep. CFSTI.

Hydrogen pumping speeds were found as a function of the quantity of hydrogen adsorbed or condensed in a helium cryopump. Pumping speed measurements were compared at 2.6 and 4.2°K by evacuation of the helium Dewar to 90 torr. Speeds were obtained for the bare cryopump Dewar and for the Dewar with its surface area increased by a copper felt pad clamped to its bottom. After admission of 0.1 torr-liter of hydrogen at 4.2°K, the copper-felt-covered Dewar had a speed of 320 liters/sec and the bare Dewar 20 liters/sec for an inlet pressure in the 10^{-7} torr range. When the Dewar temperature was reduced to 2.6°K, with the same amount of hydrogen admitted and the same inlet pressure, the speed of the copper-felt-covered Dewar remained the same (320 liters/sec) while the bare Dewar speed increased to greater than 600 liters/sec. These results are explained in terms of a higher surface temperature for the copper-felt-covered Dewar as compared with the bare Dewar. It is experimentally verified that at 2.6°K the equilibrium vapor pressure of condensed hydrogen is sufficiently low that there is no need to rely on adsorption phenomena to provide high hydrogen-pumping speeds. (auth)

32360 ULTRAHIGH VACUUM SEAL. Levenson, Leonard L.; Milleron, N. (to U. S. Atomic Energy Commission). U. S. Patent 3,331,526. July 18, 1967.

An ultrahigh vacuum seal comprising a closely-fitting disk that

is disposed in the opening to be sealed is described. An annular inflatable bellows is disposed on the periphery of the disk so that the bellows lies adjacent the wall which defines the opening to be sealed. In the operation of the seal, the disk is positioned in the opening and the bellows is inflated by admitting hydraulic fluid under pressure to the bellows. The pressure of the inflated bellows forces a flexible annular band against the wall of the opening thereby providing a leakproof vacuum seal. (AEC)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 33806, 33954, 33965, 33986, 34020, and 34029.

32361 (AAEC/TM-384) FULL-ENERGY-PEAK EFFICIENCIES OF THREE GAMMA-RAY DETECTORS. Hanna, G. L.; Walker, D. G.; Beach, P. M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr. 1967. 20p. Dep.

Two sodium iodide scintillators and a lithium-drifted germanium detector are used in the analysis by gamma-ray spectrometry of gaseous fission products obtained in sweep-capsule fission product release experiments. A description is given of the measurement of full-energy-peak efficiencies of the three detectors for the source geometries used in counting the fission product samples. Experimental efficiencies are compared with calculated efficiencies for one of the sodium iodide detectors. Measurements made of the resolutions obtained with each detector are also noted. (auth)

32362 (ANS-SD-2) PROCEEDINGS OF THE SPECIAL SESSION ON FAST NEUTRON SPECTROSCOPY PRESENTED AT THE 1964 WINTER MEETING, SAN FRANCISCO, CALIFORNIA, DECEMBER 1, 1964. Greenborg, J. (comp. and ed.) (American Nuclear Society, Hinsdale, Ill.). Feb. 15, 1965. 235p. (CONF-654-(Suppl.1)). ANS.

Separate abstracts are prepared for 6 of the 10 papers presented. Four papers were previously included in NSA. For abstracts of these papers see 19: 13735, 21735, 22801, and 23618. (B.G.D.)

For abstracts of individual papers see: 32363–32368.

32363 (ANS-SD-2, Paper 1) METHODS OF FAST-NEUTRON SPECTROSCOPY FOR REACTOR SHIELDING. Maienschein, F. C. (Oak Ridge National Lab., Tenn.). 12p.

Various methods of fast neutron spectroscopy for reactor shielding are discussed. These are proton recoil, nuclear reaction, threshold detector, and time-of-flight methods. (B.G.D.)

32364 (ANS-SD-2, Paper 2) NEUTRON SPECTRA IN SHIELDS BY TIME-OF-FLIGHT. Russell, J. L. Jr. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). 10p.

The use of time-of-flight methods for determining high energy neutron spectra in bulk media is discussed. Preliminary data are presented on neutron spectral measurements at a lead–graphite interface, in depleted uranium, and in liquid hydrogen at 0°K as a function of thickness. (B.G.D.)

32365 (ANS-SD-2, Paper 3) IN-CORE EXPERIMENTS WITH A ^{6}Li "SANDWICH" FAST NEUTRON SPECTROMETER. Huber, R. J. (Argonne National Lab., Idaho Falls, Idaho). 18p.

The use of surface barrier detector–lithium-6 sandwiched fast neutron spectrometers for in-core measurements in the Zero Power Reactor III Assembly 45, a zoned fast critical having a soft (for fast reactors) neutron energy spectrum, and the Argonne Fast Source Reactor is described and the data obtained are presented. (B.G.D.)

32366 (ANS-SD-2, Paper 4) FAST NEUTRON SPECTROSCOPY BY 4π-RECOIL PROPORTIONAL COUNTING. Bennett, E. F. (Argonne National Lab., Ill.). 27p.

The Am-α-Li neutron spectrum (30 keV to 1.2 MeV), and the 1/E slowing-down spectrum (10 keV to 100 keV) from a moderated Pu-α-Be source, were measured using 4π-recoil proportional counter probes. A discussion of the measurements, including counter calibration and gamma background discrimination, is given. (auth)

32367 (ANS-SD-2, Paper 8) ^{3}He FAST NEUTRON SPECTROMETER WITH EXTENDED ENERGY RANGE. Sayres, A. (Columbia Univ., New York. Dept. of Physics). 11p.

The use of ^{3}He-filled proportional counters for fast neutron spectroscopy is discussed. The performance characteristics and the advantages of the ^{3}He-filled fast neutron spectrometer are good energy resolution (between 3 and 5% FWHM), high efficiency (between 10^{-4} and 10^{-3}), wide energy range (100 keV < E_n < 10 MeV), and rejection of gamma rays by the high Q (764 keV) and pulse rise time discrimination. (B.G.D.)

32368 (ANS-SD-2, Paper 9) RECENT DEVELOPMENTS IN THE PROTON-RECOIL SCINTILLATION NEUTRON SPECTROMETER. Burrus, W. R.; Verbinski, V. V. (Oak Ridge National Lab., Tenn.). 41p.

The details of a pulse-shape discrimination circuit for a proton-recoil scintillation neutron spectrometer which will reduce the gamma sensitivity of the spectrometer are described. (B.G.D.)

32369 (BMwF-FBK-67-31) EIN ZAEHLROHRTELESKOP MIT ANALOGRECHNER ZUR IMPULSBESTIMMUNG VON μ MESONEN IN EINEM HOCHENERGIESPEKTROGRAPHEN. (A Counter Telescope With Analog Computer for Momentum Analyzing of Muons in a High Energy Spectrograph). Dau, W. D. (Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik). Apr. 1967. 46p. (In German). Dep.

The momentum of cosmic ray muons can be measured by means of a magnetic spectrograph. Two trays of Geiger–Müller counters are placed above and two trays below the field of an electromagnet. When a muon traverses the telescope one counter discharges in each tray. The momentum of the muon then can be calculated in a rough manner out of the geometrical positions of the discharged counters. An electronic computer was developed for the calculation of the momentum. The computer is based on analog circuits. The polarity of the output pulse refers to the sign of charge of the muon and the height is proportional to the momentum. The triggering pulse appears nearly 5 μsec after a muon has passed the counter arrangement. (auth)

32370 (JINR-P1-3349) KALIBROVOCHNYE KRIVYE V KOORDINATAKH (ΣR,d) I IZMERENIE ENERGII γ-KVANTOV V DIAPAZONE 40–4000 MeV V KSENONOVOI PUZYR'KOVOI KAMERE. (Calibration Plots in (ΣR,d) Coordinates and the γ-Quanta Energy Measurement in the Region of 40–4000 MeV in a Xenon Bubble Chamber). Martynov, A. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 14p. (In Russian). Dep.

An idea of the cutoff criterion of the shower from γ quantum, converted in an operating volume of a xenon chamber, and the process of obtaining empirical calibration plots and an empirical field of fluctuation errors, allowing measurements of both the γ-quantum energy and the error in this measurement, is discussed in detail. (auth)

32371 (MURA-725) DESIGN OF IONIZATION SPECTROMETERS USING IRON AND SCINTILLATORS, FOR THE DETECTION OF HADRONS IN THE 100 TO 100 GeV RANGE. Lyon, D. E. Jr. (Michigan Univ., Ann Arbor); Subramanian, A. (Tata Inst. of Fundamental Research, Bombay (India)). May 1967. 22p. Dep. CFSTI.

Design specifications for total absorption spectrometers using plastic scintillators and iron to detect and measure the energies of hadrons in cosmic radiation in the energy range 100-1000 BeV are given, based on results obtained with an experimental spectrometer set up and operated at Echo Lake, Colorado (elevation 10,600 ft.) during the fall and winter of 1966-67. With a sample of 2000 events to study, it was concluded that the energy resolution with such a device is ±20%, if the spectrometer is constructed using a total thickness of iron of at least 1000 gm/cm^2, and using plastic scintillator probes with a thickness of less than 2 gm/cm^2 to sample the nuclear cascade development, separated at most by 100 gm/cm^2 of absorber material and placed with this frequency throughout the entire thickness of the absorber. (auth)

32372 (RHEL/R-129, pp 79-95) APPLIED PHYSICS DIVISION. (Rutherford High Energy Lab., Chilton (England)).

The work of the applied physics division, which is described, includes various bubble chambers, computing activities, the variable-energy cyclotron, and the electrostatic generator for Oxford University. (J.F.P.)

32373 (AEC-tr-6719, pp 7-18) MEASURING EPITHERMAL NEUTRON SPECTRA WITH RESONANCE MONITORS. Avaev, V. N.; Egorov, Yu. A. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

A selection of radioactive resonance monitors for neutron spectroscopy in the epithermal region is presented. The thirteen monitors described recover a sufficiently accurate spectral distribution in the energy range from 0.46 eV to 6 keV. (auth)

32374 (AEC-tr-6719, pp 44-9) TREATMENT OF INTERMEDIATE-NEUTRON SPECTRA TAKEN WITH A TIME-OF-FLIGHT SPECTROMETER. Kramer-Agoev, E. A.; Troshin, V. S. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

Methods for the treatment of instrumental spectra obtained with a time-of-flight spectrometer are described. Different techniques for approximate solution of systems of integral equations are evaluated. (auth)

32375 (AEC-tr-6719, pp 50-3) SIMPLE METHOD FOR STUDYING CONTINUOUS FAST-NEUTRON SPECTRA. Doro-

shenko, G. G.; Zolotukhin, V. G. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

A simple method for the treatment of instrumental spectra of fast neutrons obtained with a single-crystal spectrometer is proposed. The method is based on a single n-p scattering and recovers the true spectrum to within 10–15%. (auth)

32376 (AEC-tr-6719, pp 54-8) STUDY OF SHIELDING PROPERTIES OF MATERIALS WITH THE AID OF FISSION CHAMBERS. Konstantinov, L. V.; Serebrennikov, Yu. M. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

The design, operation, and counting responses of fission chambers are discussed. (B.G.D.)

32377 (AEC-tr-6719, pp 59-63) GAMMA-SPECTROMETER WITH AN ANTICOINCIDENCE SCINTILLATION SHIELD. Gusev, N. S.; Ivanova, Z. M.; Konstantinov, I. E. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

A NaI(Tl) gamma spectrometer with an anticoincidence scintillator shield is described. The instrument will measure ^{137}Cs activities of the order of 10^{-11} Curies. (auth)

32378 (AEC-tr-6719, pp 64-70) GAMMA-SPECTROMETERS WITH SEMICONDUCTOR DETECTORS. Stolyarova, E. L. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

The papers published in the U.S.S.R. and elsewhere on the various aspects of silicon and germanium gamma spectrometers are surveyed. (auth)

32379 (AEC-tr-6719, pp 90-2) CORRECTIONS FOR ABSORPTION IN ABSOLUTE BETA-ACTIVITY MEASUREMENTS. Baranov, V. F. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

Corrections for absorption in absolute β-activity measurements with end-window counters are presented. The corrections are based on the extrapolation of the absorption curve to zero absorption thickness and assuming exponential absorption of β-radiation in matter. (B.G.D.)

32380 (AEC-tr-6719, pp 93-9) ABSORPTION OF MONOENERGETIC AND BETA-SPECTRUM ELECTRONS IN ALUMINUM. Baranov, V. F. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

The absorption of monoenergetic electrons from 0.1 to 1.5 MeV in aluminum was measured using a magnetic electron monochromator. End-window counters enclosed in a vacuum chamber were used as detectors. The absorption curves for some β-emitters were also calculated from the experimental data. (B.G.D.)

32381 (AEC-tr-6719, pp 100-2) END LOSSES IN FILLED COUNTERS. Kolobashkin, V. M.; Greshilov, A. A.; Ushakova, N. P. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

When the activity of gaseous β-emitters is measured with a single filled cyclindrical counter, the counting losses produced by field reduction at the counter ends can be allowed for by introducing a correction $y = (n-N/N)$ where n is the number of disintegrations in unit time and N the recorded counting rate. (B.G.D.)

32382 (AEC-tr-6719, pp 109-10) ESTIMATING THE RELATIVE CONTRIBUTION FROM DIFFERENT SCINTILLATION COMPONENTS. Doroshenko, G. G. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

The importance of the electron time-of-flight spread in the photomultiplier for evaluating the relative contribution from the different scintillation components is discussed. (auth)

32383 (AEC-tr-6719, pp 111-12) ESTIMATE OF THE OPTIMAL SIZE OF THE SCINTILLATOR FOR SINGLE-CRYSTAL FAST-NEUTRON SPECTROMETERS. Doroshenko, G. G. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

A method for estimating the optimal size of a scintillator for single-crystal fast-neutron spectrometers is described. (auth)

32384 (AEC-tr-6719, pp 115-17) STABILIZATION CIRCUIT FOR THE AMPLIFIER CHANNEL OF A FAST-NEUTRON SPECTROMETER. Doroshenko, G. G.; Fedorov, V. A.; Leonov, E. S. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

A stabilization circuit for the amplifier channel of a fast neutron spectrometer is described. The circuit was designed in order to obtain high stability and precision in the instrumental spectrum. (B.G.D.)

32385 (ANL-Trans-493) BEAM PATH IN A NEUTRON SPECTROMETER FOR SINGLE CRYSTAL INVESTIGATIONS. Dachs, Hans. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Z. Kristallog., 115: 80-92(1961). 17p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Formulas are derived which concern the half width of single crystal reflections of zero and higher levels, and which determine the "aperture" of the counter tube needed for the measurement of integral intensities. It is investigated how far reflections of higher levels can be measured. (auth)

32386 PERFORMANCE OF A LARGE-AREA WHOLE-BODY COUNTER. Barnaby, C. F.; Smith, T. (London Univ.). J. Sci. Instrum., 44: 499-505(July 1967).

The design and performance of a cheap but sensitive whole-body counter which incorporates a large area organic scintillator in the form of a movable detector are described. The performance and sensitivity of the counter are shown to be adequate for a large number of clinical investigations using amounts of administered radioactivity well below the maximum body burdens recommended by the International Commission on Radiological Protection. An investigation of the sensitivity of the counting efficiency to the source-detector geometry has led to the adoption of a counting technique which is relatively independent of the location of a point source within the trunk region of a subject. Use of this method permits the measurement of the natural ^{40}K content of a standard man to 3% accuracy of counting statistics in a counting time of 1000 sec. For cheapness, a chalk shield has been used and the cost of materials for a counter based on this design, using an efficient liquid scintillator, could be as low as £300, excluding the cost of electronic units. (auth) (UK)

32387 CERTAIN PROCESSES IN DECLINING G-M COUNTER CONNECTED WITH CHANGES IN ITS PHOTOSENSITIVITY. Bonchev, T.; Aneva, N. (Sofia Univ.). Compt. Rend. Acad. Bulg. Sci., 20: 173-5(1967).

The equipment and techniques used to study the changes in photosensitivity due to declining processes in G–M counters are described. (B.G.D.)

32388 NONLINEAR AMPLIFIER FOR USE IN MIXED RADIATION REM RESPONDING RADIATION METERS. Baum, John W. (Brookhaven National Lab., Upton, N. Y.). Health Phys., 13: 775-81(July 1967).

The development of a survey instrument suitable for measurements in mixed radiation fields around nuclear reactors and accelerators is described. A 4-in. diameter Rossi-type tissue-equivalent spherical proportional counter is used as the radiation detector. Pulses from the counter are amplified by a special operational amplifier which serves to convert the detector output into a pulse spectrum which is weighted for quality factor and thus represents dose equivalent. In the preliminary laboratory studies an analog-to-digital converter is employed to transform the operational amplifier output pulses to pulse trains which can be counted or passed through a count-rate-meter. The required gain characteristics of the nonlinear operational amplifier were determined by considering theoretical pulse height spectra expected from the detector when exposed to fields of radiation containing particles of both single and mixed LET. Design principles of a circuit which has approximately the required gain are discussed along with preliminary laboratory tests of the overall system response to pure and mixed radiation fields. The amplifier has a wide dynamic range, making it possible to measure dose from particles having LET from 0.2 to about 200 keV/μ of tissue. (auth)

32389 EXPERIENCE WITH EMULSION COUNTING OF TRITIUM. Van Der Laarse, J. D. (Koninklijke/Shell-Laboratorium, Amsterdam). Int. J. Appl. Radiat. Isotop., 18: 485-91 (July 1967).

The nonionic surfactant Triton-X-100 has been described as an emulsifier for liquid scintillation counting of aqueous samples. A systematic study of the water/toluene/Triton systems for tritium counting revealed interesting characteristics that should be taken into account. The degree of homogeneity of the systems varies sharply with composition. Slight changes in composition may considerably change the appearance, which can vary from completely clear to opalescent or opaque-white. The counting efficiency varies strongly, not only between clear and opaque systems, but even in the clear regions of the composition diagram. Nearly all the liquid compositions, even in the clear region, are in fact emulsions of water in toluene/Triton. Therefore, a part of the β energy of tritium will be lost through self-absorption, and standardization with tritiated-toluene standard leads to erroneous results. The systems are reproducible, however, and it is very well possible to perform reliable measurements once the peculiarities have been suitably

mapped. Not more than microlitre amounts of tritiated water should be used for standardization. (auth)

32390 STUDY OF THE ENERGY SENSITIVITY OF FAST-NEUTRON RADIOMETERS. Fominykh, V. I. Izmer. Tekh., No. 5, 53-5(May 1967). (In Russian).

At the present time, the RUP-1, KRAN-1 and SCh-3 industrial radiometers are used for measuring fast-neutron fluxes; these instruments contain a pressed mixture of Plexiglass and silver-activated zinc sulfate. The instruments are calibrated with PoBe and PuBe sources, with mean energies of 4.5 and 4.2 MeV, respectively, in the 0 to 11 MeV range. However, the instruments are mostly used for the measurement of fission-neutron spectra of scattered beams, with energies at about or below 1 MeV. In order to determine the error arising from the differential energy response of the instrument, neutron sources with varying energies were used for calibration. The measurements were carried out in open geometry, taking into account the neutron-beam symmetry of each source. It was concluded that the beam density error should be attributed to the energy range, in which the calibration was carried out. The sensitivity of new types of detectors should be checked with monoenergetic neutron beams before adopting them for general use. Systems with uniform sensitivity at various energy ranges, such as polyethylene counters, are best suited for measuring fast-neutron flux densities. (TTT)

32391 USE OF α-RADIATION SOURCES FOR THE CALIBRATION AND DETERMINATION OF THE BASIC PARAMETERS OF THE SEMICONDUCTOR TYPE α SPECTROMETERS. Stepanov, E. K.; Tyutikov, N. V. Izmer. Tekh., No. 5, 49-52(May 1967). (In Russian).

The basic parameters of the semiconductor-type α detectors include their energy resolution, integral nonlinearity, time instability, and behavior with respect to frequency changes and amplitude overload. In view of the general unreliability of the previously used methods, a new technique based on the use of α sources was developed. The maximum of the amplitude pulse distribution of monoenergetic α particles served as reference. Tests were carried out with various α sources, such as ^{233}U, ^{239}Pu, and ^{241}Am, using a silicon surface detector and a ^{226}Ra source for reference. The effect of the source on the resolution was illustrated by a numerical example. The time instability was found to amount to 0.2% after 7 hours of operation. It was also found that frequency loading causes a drift of the energy spectrum of the α emitters. The effect of periodic and statistical loads on the energy spectrum was found to be nonuniform. (TTT)

32392 WIRE SPARK CHAMBERS. Baker, Winslow. Phys. Today, 20: No. 7, 41-5(July 1967).

The use of wire spark chambers as particle detectors is discussed. Topics included were the design and operation of the chamber, the readout system, and its use with on-line computers. (B.G.D.)

32393 MOESSBAUER EFFECT. Wertheim, Gunther K. Phys. Today, 20: No. 7, 31-7(July 1967).

An elementary discussion of the theory, experimental setup, and equipment used for studying the Moessbauer effect was presented. Topics included were applications, energy modulation, improvement in signal-to-noise ratio, distortion in the data, data handling, and gamma-ray detection. (B.G.D.)

32394 LIMIT OF RESOLUTION OF SOME METHODS OF MEASUREMENT OF GRAIN DENSITY. Dellagi, Mohamed (Faculte des Sciences, Tunis, France). Rev. Phys. Appl., Suppl. J. Phys., 1: 297-9(Dec. 1966). (In French).

Methods for grain density measurements in nuclear emulsions are considered. These methods are the determination of the mean length of gaps, determination of the mean length of bundles, and measurements with constant track length. Calculations are made using a model with equivalent and spherical grains, where the projection of their centers is distributed at random, with a certain mean density. (J.F.P.)

32395 WHOLE BODY COUNTER RESEARCH IN RADIOBIOLOGY, NUCLEAR MEDICINE, AND CLINICAL MEDICINE. Kruk, Wieslaw Zbigniew. Pol. Przegl. Radiol. Med. Nuklearnej, 31: 305-8(Mar.-Apr. 1967). (In Polish).

The recent state of the problem of whole body counter research in radiobiology, nuclear medicine and clinical medicine are presented. Structural details of the counting device are presented on a Japanese model example. The application of the discussed technique in various research fields in medicine are presented. The article presents also the perspectives of this new research method. (tr-auth)

32396 THE ION OPTICS OF A COMMERCIAL n = ½ MAGNETIC SPECTROMETER. Freiesleben, H.; Kamke, D.; Walcher, Th. (Univ., Marburg/Lahn, Ger.). Nucl. Instrum. Methods, 53: 141-52(July 1967). (In German).

The magnetic field of a double focusing magnetic spectrometer was measured with a high precision Hall generator. The exactly known field including all distortions depending on the main field strength is a basis for numerical calculations of ion optics. Results are experimentally checked by using α-particles of ThB decay, and excellent agreement between both is found. Therefore an absolute calibration of the spectrometer can be given. (auth)

32397 MECHANICAL CONSTANT VELOCITY DRIVE FOR MOESSBAUER-SPECTROSCOPY OF HEMOGLOBIN. Kappler, H. M.; Trautwein, A.; Mayer, A.; Vogel, H. (Technische Hochschule, Munich). Nucl. Instrum. Methods, 53: 157-62(July 1967).

A mechanical constant velocity drive for Moessbauer-effect measurements is described. The velocity generating system is a heavy, rotating disk with a helicoidal surface at the outer circumference. The disk is driven by a preselectable synchronous system on the basis of a 100 kcps quartz generator. The Moessbauer experiments were performed with this mechanical constant velocity drive and an electrodynamical triangular velocity drive. The isomeric shift, the quadrupole splitting and the temperature dependence of oxygenated and deoxygenated hemoglobin are discussed. (auth)

32398 PREPARATION OF THERMAL NEUTRON SCINTILLATORS BASED ON A MIXTURE OF ZnS(Ag), ^{6}LiE AND POLYETHYLENE. Tojo, T.; Nakajima, T. (Japan Atomic Energy Research Inst., Tokyo). Nucl. Instrum. Methods, 53: 163-6(July 1967).

Scintillator mixtures of ZnS(Ag), ^{6}LiF and polyethylene are prepared in varying mixture proportions and thicknesses with a view to determine optimum recipe for the detection of thermal neutrons. ^{6}Li of ^{6}LiF used is enriched to 96%. The most efficient scintillator for thermal neutrons is obtained at the mixture proportion ZnS(Ag) : ^{6}LiF : polyethylene = 5 : 1 : 1 by weight and at a thickness of 0.76 mm. The counting efficiency (counts/thermal neutron flux) of this scintillator is ≈26%. (auth)

32399 INSIGNIFICANCE OF AZIMUTHAL FOCUSING IN IRON-FREE TOROIDAL FIELD SPECTROMETERS. Wagner, F.; Freedman, M. S.; Porter, F. T. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 53: 167-71(July 1967).

By a computation of the field configuration in a simulated iron-free toroidal particle spectrometer constructed of coil sections with parallel faces, it is shown that the ratio of radial to azimuthal field components is very small, and hence, that the azimuthal focusing effect of Bartis is of negligible importance. (auth)

32400 VELOCITY SHIFTS IN MOESSBAUER SPECTROSCOPY. Hershkowitz, N. (Johns Hopkins Univ., Baltimore, Md.). Nucl. Instrum. Methods, 53: 172(July 1967).

Velocity shifts in the apparent positions of the structure observed in Moessbauer absorption experiments are shown to be simply related to the experimental geometry when thin absorbers are used. (auth)

32401 THIN FORMVAR COATED COUNTER WINDOWS. Morrison, R. A.; Reed, K. A. (Univ. of Chicago). Nucl. Instrum. Methods, 53: 173-4(July 1967). (EFINS-66-102).

By coating pyroxylin films with formvar a pressure-tight window can be produced that will stand up better under roughing and venting of the vacuum system than the same thickness of pure pyroxylin. Typical thickness is 45 $\mu g/cm^2$. With a surface area of 0.2 $in.^2$ it will withstand a pressure of 10 cm Hg before significant leakage occurs. (auth)

32402 FABRICATION OF AN ELLIPSOIDAL MIRROR FOR USE IN A THRESHOLD GAS CHERENKOV COUNTER. Morrill, D. H.; Wong, M. (Harvard Univ., Cambridge, Mass.). Nucl. Instrum. Methods, 53: 175-6(July 1967).

A method of fabricating an ellipsoidal mirror from epoxy-fiberglass for use in a threshold gas Cherenkov counter is described. (auth)

32403 RESPONSE FUNCTIONS OF A GERMANIUM–SODIUM IODIDE DETECTOR SYSTEM. Allen, B. J.; Bird, J. R.; Engstrom, S. (Australian Atomic Energy Research Establishment, Lucas Heights). Nucl. Instrum. Methods, 53: 61-70(July 1967).

A gamma ray spectrometer is described which uses a lithium drifted germanium diode or a sodium iodide crystal as a central detector in conjunction with an annular segmented sodium iodide assembly. The system can operate as a total absorption, anti-coincidence, or pair spectrometer and individual detectors may be used separately. Thus, the requirements of high resolution or high efficiency gamma ray spectroscopy can be met by suitable choice of mode of operation. The various modes of operation are compared and typical results given to illustrate their performance

at a variety of gamma ray energies. A detailed analysis is given of the response of a 30 cm^3 Ge(Li) detector for gamma rays up to 17.6 MeV. (auth)

32404 DETERMINATION OF THE QUALITY FACTOR IN A MIXED FIELD OF GAMMA-RAYS AND NEUTRONS BY AN IONIZATION CHAMBER FILLED WITH A DIELECTRIC LIQUID. II. Ladu, M.; Pelliccioni, M.; Roccella, M. (CNEN, Frascati, Italy). Nucl. Instrum. Methods, 53: 71-6(July 1967).

After studying the response of a hexane-filled ionization chamber to gamma rays and neutrons the quality factor in a gamma ray–neutron mixed field was measured. The precision of the method used was discussed and compared with other methods previously used. (B.G.D.)

32405 ARRAY OF OXIDE-PASSIVATED SILICON p-n JUNCTION DETECTORS FOR A BROAD-RANGE MAGNETIC SPECTROMETER. Kobayashi, T.; Takayanagi, S. (Tokyo Shibaura Electric Co., Ltd.). Nucl. Instrum. Methods, 53: 77-81(July 1967).

An array of 250 oxide-passivated silicon p-n junction detectors is made for use in the focal plane of a broad-range magnetic spectrometer. The individual detector has an effective rectangular area of 2 mm wide and 8 mm long, and is protected with a silicon dioxide layer approximately 3000 Å thick made by a fast pyrolytic deposition method. Details of the construction methods and some properties of an individual detector are described. The performance of the detector array is also reported. (auth)

32406 ELECTRICAL DETECTION SYSTEM FOR BROAD-RANGE MAGNETIC SPECTROMETERS. Matsuda, K. (Inst. of Physical and Chemical Resarch, Saitama, Japan); Nonaka, I.; Omata, K.; Yagi, K.; Koike, M. Nucl. Instrum. Methods, 53: 82-6(July 1967).

The performance of the electrical detection system used for the spectrum analysis of broad range magnetic analyzers is described. Two kinds of detector array are used as the position indicator; the one is an array of 250 solid state detectors and the other is an array of 200 proportional-scintillation counter telescopes. They are followed with the same system of pulse handling. Informations are stored in an 1024 channel PHA core memory. Then the spectrum obtained can be processed with the PHA function. (auth)

32407 THE BROOKHAVEN HIGH FLUX BEAM REACTOR FAST CHOPPER FACILITY. Chrien, R. E.; Reich, M. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods, 53: 93-107(July 1967). (BNL-11210).

A pulsed neutron time-of-flight system designed primarily for the investigation of radiative transitions induced by neutron capture in the epithermal region is described. The neutron burst is formed by a massive rotor fabricated from tungsten, nickel, and steel placed at the radial beam tube at the Brookhaven High Flux Beam Reactor (HFBR). A novel in-pile collimator is used to produce a relatively narrow spot size at the target, normally situated 22 m from the rotor, without the use of external collimation. Details of design, construction, and performance are given. (auth)

32408 A MULTICOUNTER GONIOMETER FOR GAMMA-GAMMA ANGULAR CORRELATION MEASUREMENTS. Hayashi, T.; Okano, K.; Yuasa, K.; Kawase, Y.; Uehara, S. (Kyoto Univ.). Nucl. Instrum. Methods, 53: 123-7(July 1967).

A multicounter goniometer for gamma-gamma angular correlation measurements was newly designed and constructed. It consists of 12 photomultipliers with NaI(Tl) crystals placed radially at intervals of 30° and a 12 × 12 coincidence matrix circuit which follows 12 linear amplifiers and 2 × 12 single channel pulse height analyzers. Coincidence counts at 11 angles between 30 and 330° are taken simultaneously for each of the 12 counters, so that with this method angular correlation measurements can be made within a time reduced by a factor 12 × 11, as compared with the ordinary method. (auth)

32409 SOME RESULTS IN TIME MEASUREMENTS WITH NaI(Tl) SCINTILLATORS. Grabari, V. (Inst. for Atomic Physics, Bucharest). Nucl. Instrum. Methods, 53: 136-40(July 1967).

The time properties of NaI(Tl) scintillators and the performances of the avalanche transistor as a pulse shaping device are examined. A time-to-amplitude converter with electrical resolving time of 70 ps is described. In a fast-slow arrangement a resolving time of 1.55 ns (511–511 keV γ-rays from ^{22}Na source) with 8.1% energy resolution, and respectively 1.15 ns with 8.7% was obtained. The energy dependence of the resolving time was investigated in the 100–511 keV range. (auth)

32410 ON THE ACCURACY OF ACCEPTOR COMPENSATION BY LITHIUM ION DRIFT. Gibbons, P. E.; Iredale, P. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 53: 1-6(July 1967). (AERE-R-5339).

The accuracy of compensation for acceptor impurities in semiconductors by the lithium ion drift technique is shown to be dependent upon the acceptor distribution. Exact compensation can only be achieved if the acceptor concentration, N_A, is uniform or alternatively if the applied drifting field is orthogonal to grad N_A. Detailed calculations were made for two geometries, planar and coaxial, when the acceptor concentration has a linear gradient in the direction of drift. The imbalance in the compensation and its effect are discussed. (auth)

32411 GAS PROPORTIONAL SCINTILLATION COUNTER. Conde, C. A. N.; Policarpo, A. J. P. L. (Univ. of Manchester, Eng.). Nucl. Instrum. Methods, 53: 7-12(July 1967).

The effect of a radial electric field on the scintillations produced in argon by alpha particles from a ThB source was studied. Following the fast primary scintillation there is a second slower component that increases with the field and shows an intrinsic energy resolution of about 2.3%. The performance of this scintillation counter is analyzed and it is shown that it can be favorably compared with most scintillation and proportional counters. A preliminary discussion on the light production mechanism is given. (auth)

32412 DEFINITION AND REALIZATION OF CRITICAL FOCUSING CONDITIONS OF $\pi\sqrt{2}$ MAGNETIC FIELD AT HIGH RESOLUTION. Bergkvist, K.-E.; Hollander, J. M. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 53: 25-8(July 1967).

An analysis is given of the conditions necessary for achieving a favorable solid angle at high resolution in a $\pi\sqrt{2}$ beta-spectrometer in the case where certain imperfections in the magnetic field shape are present. It is shown that one can achieve satisfactory radial focusing under field conditions less narrowly restricted than those implied by the theoretical field. This allows a fairly simple way to correct for minor imperfections in a spectrometer field. An application to the Berkeley $r_0 = 50$ cm iron-free $\pi\sqrt{2}$ beta spectrometer is described. (auth)

32413 MEASUREMENT OF X-RAY SPECTRA WITH LITHIUM-DRIFTED GERMANIUM SEMICONDUCTOR-DETECTORS. Drexler, G.; Perzl, F. (Gesellschaft fuer Strahlenforschung mbH, Munich). Atompraxis, 13: 185-7(Apr.-May 1967). (In German).

Measurements of the spectral distribution of low-energy bremsstrahlung are rather difficult. The accuracy of the measurement using NaI(Tl) scintillation spectrometers is not always sufficient. Studies were made as to the suitability of lithium-drifted germanium detectors for the measurement of x-ray spectra. It is necessary to have germanium detectors with very thin entrance windows and a sufficient drifted region for total absorption. The good energy resolution of these semiconductor detectors is then usable also for the low-energy range. As an example, some x-ray spectra are shown. (auth)

32414 THE DETECTION OF ^{42}K BY THE CHERENKOV EFFECT. Francois, B. (Hopital de l'Antiquaille, Lyon). Int. J. Appl. Radiat. Isotop., 18: 525-31(July 1967). (In French).

Production of Cherenkov light was used to detect the hard β-emitter ^{42}K in aqueous media and human urine with a liquid scintillation spectrometer. With optically transparent solutions, the signal was found to be proportional to the absolute activity in the range 1 to 25 nCi. The detection efficiency (cpm/dpm) was as high as 62%. The average value of signals from urines enriched in ^{42}K did not exceed 48% of that of water reference standards. Color-quenching was poorly corrected by adsorption on vegetal charcoal or by internal standardization. After mineralization, urines recovered excellent optical transmissions and delivered 98.8% ($\sigma = 0.97\%$) of the activity of standards treated in the same way as the urines. The effects of chemical (solute) quenching are discussed. This technique is now used for exchangeable potassium routine determinations in man; it allows the measurement of large volumes of solutions and a counting of ^{42}K free of soft β-emitters such as tritium. (auth)

32415 GEOMETRICAL EFFECTS ON THE RESPONSE OF THE NATIONAL PHYSICAL LABORATORY IONIZATION CHAMBER TYPE 1383 A. Heydorn, K. (Research Establishment, Risoe, Denmark). Int. J. Appl. Radiat. Isotop., 18: 479-83 (July 1967).

The variation in ionization current produced by radial and axial displacement of radioactive sources in the cavity of the re-entrant γ-ionization chamber was measured. Approximate calculations are presented, which are in agreement with observed data for small cobalt-60 sources within a standard deviation of <0.2% for the main volume of the cavity. Deviations are observed for low-energy γ-ray emitters, and new calibration data for some of these are presented. (auth)

32416 PROTON RECOIL TRACK COUNTING BY TELEVISION. Samandzich, B. G.; Kathoen, R. L. (Univ. of California, Livermore). Health Phys., 13: 813-14(July 1967).

Nuclear track emulsions are commonly used to determine personnel exposures to neutrons. Direct counting of proton recoil tracks is a time-consuming and tedious task. Projection microscopy has been suggested as a means of reducing the time and increasing the ease of operation, but has several obvious disadvantages, including requirements for a dark or semi-darkened room and for careful alignment of the microscope and screen. An attempt is described to couple a closed-circuit television system with the microscope. The initial results, obtained with a 545-line sweep-beam television camera and a 21-in. monitor, were promising, and efforts toward fully developing a practical system are described. (auth)

32417 A LARGE WELL CRYSTAL WITH ANTICOINCIDENCE SHIELDING. Wogman, N. A.; Robertson, D. E.; Perkins, R. W. (Battelle Memorial Inst., Richland, Wash.). Health Phys., 13: 767-73(July 1967). (BNWL-SA-830).

An anticoincidence shielded gamma-ray spectrometer was fabricated using a $9\frac{3}{8}$-in. diameter by $8\frac{13}{16}$-in. thick NaI(Tl) crystal with a well of sufficient size to accommodate a 500 ml polyethylene bottle. The crystal is shielded from its phototubes by a 5-in. thick pure NaI light pipe and is enclosed in a 36-in. diameter by 36-in. thick plastic phosphor which serves as an anticoincidence annulus. A 4-in. thick boron–paraffin shield located between the plastic phosphor and the massive lead shield serves to reduce the background contribution from cosmic-ray-produced neutrons. The back background in the energy region of 0.1 to 4 MeV is reduced by five- to thirtyfold by the combined shielding techniques. The Compton response for a ^{65}Zn point source is reduced by two- to threefold, while that of ^{60}Co below the 1.17 MeV photopeak is reduced by six- to sevenfold. For the standard geometry 500 ml aqueous samples the photopeak counting efficiency of ^{65}Zn in the large well crystal is forty times higher than with a 3-in. × 3-in. crystal yet the background of the large well crystal is only twice as high. (auth)

32418 SEMICONDUCTOR DETECTORS FOR NUCLEAR RADIATION. Tanarro, Agustin; Gaeta, Rafael. Energ. Nucl. (Madrid), 10: 467-82(Nov.-Dec. 1966). (In Spanish).

The principal advantages of semiconductor detectors are outlined. The characteristics of homogeneous detectors, junction detectors, diffused junction detectors with surface barrier, and Li-compensated detectors are discussed. The form of pulses obtained from these detectors are described and the characteristics of amplifiers sensitive to the electric charge are given. The type of electronic instrumentation used in semiconductor detectors is outlined, and discrimination between different types of particles is considered. (J.S.R.)

32419 CORRECTIONS TO SPECTRA MEASURED BY ^{6}Li AND ^{3}He SEMICONDUCTOR SPECTROMETERS IN AN ISOTROPIC NEUTRON FLUX. Silk, M. G.; Windsor, Margaret E. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Eng., 21: 17-33(Jan. 1967).

Correction factors are calculated which allow for particles escaping detection when these spectrometers are used in isotropic neutron fluxes. For fast-neutron spectra measurements between 1 MeV and 6 MeV the maximum correction factor is 7 percent for the ^{6}Li spectrometer and 10 percent for the ^{3}He spectrometer. (auth) UK)

32420 NUCLEAR RESEARCH DEVELOPMENT AT CERN, NO. II: MEASUREMENT AND ANALYSIS. Engineer, 223: 914-6(June 16, 1967).

New developments at the centre described include the on-line isotope separator (ISOLDE) fed by the 600 MeV synchro-cyclotron, and a beam line for neutrinos for the study of weak interactions. Expansion of computing facilities is in progress to meet the demands of "on-line" techniques in electronic counter experiments, and also the development of flying-spot-digitizers for measuring spark chamber and bubble chamber film. The 12 computers at CERN, including a CDC 6600, are listed; another 7 are on order. (UK)

32421 IMAGE INVERSION OF GEIGER PULSE. Sastri, R. C.; Chatterjee, S. D. (Jadavpur Univ., Calcutta). Indian J. Phys., 41: 147-9(Feb. 1967).

The operating characteristics of a Geiger-Mueller counter with a circular cylindrical cathode and non-axial wire are described. (B.G.D.)

32422 COMPARISON OF SCINTILLATION METHODS FOR MEASUREMENTS OF MINIMAL ACTIVITIES OF TRITIATED WATER IN APPLICATION TO BIOLOGICAL INVESTIGATIONS. Malesa, Jan; Siwicki, Henryk (Instytutu Onkologii, Warsaw). Pol. Przegl. Radiol. Med. Nuklearnej, 31: 309-13(Mar.-Apr. 1967). (In Polish).

The comparison of two electronic systems for measurement of small activities of tritiated water in a liquid scintillator with toluene base is presented. The scintillation pulses of light were measured using one and two photomultipliers. The reduction of the photomultiplier thermal pulses was performed by freezing the scintillation probe units in both systems used. The temperature range between +15 and −10°C was chosen. In the system with single photomultiplier the possibility of measurement of minimal activities of tritiated water was at +3°C. For the system with two photomultipliers in coincidence the least measured activity was in the range of the positive temperatures of these probes. (auth)

32423 CYLINDRICAL SPARK COUNTERS AND MUON AIR SHOWERS. Parker, Jack Lindsay. Salt Lake City, Univ. of Utah, 1967. 63p.

Thesis.

A cylindrical spark counter (CSC) has been developed as an element of the Utah neutrino detector. A typical counter is 15 cm in diameter and 11 m long with an 0.25-mm center wire. A gas mixture of $\frac{2}{3}$ argon and $\frac{1}{3}$ ethylene at a total pressure of 750 torr results in a discharge sharply localized at the location of the initial ionization. Operation in the pulsed mode (6000-V clearing potential and 1.5-μsec, 2000-V pulse) makes possible economies in construction with a precision of 3 mm. Several discharges can occur simultaneously at different positions in the counter. A prototype detector containing 115 CSC operated for six months, demonstrating the stability and long life of the CSC and the ability of an array of them to give three-dimensional representations of muon trajectories through the array. About 1200 events consisting of two or more nearly parallel muons were observed with zenith angles between 45 and 90°. The rate for such events in the prototype detector is $6.8^{+1.0}_{-0.8}$ per hour. The zenith angle distribution is of the form $I \propto h(\theta)^{-2.0}$ where $h(\theta)$ is the distance to the point at which the cosmic-ray primaries have traversed 400 g/cm^2 at zenith angle θ. The rate and zenith angle distribution agree reasonably well with those predicted by calculations based on a simple model of extensive air showers. The distribution of angles between the members of muon pairs was also measured and found consistent with the angular spread predicted for muons in extensive air showers. (Dissertation Abstr.)

32424 SOLID STATE ALPHA MONITOR FOR PROCESS CONTROL /Q-3007/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1595).

2 drawings.

An α monitor, designed for process control in the Transuranium Processing Plant, is described. The monitor is packaged in a standard NIM module which allows six monitors to be placed in a single $5\frac{1}{4}$ in. bin. Two silicon surface-barrier diodes are employed. One has a surface area of 20 mm^2 and is used for α detection; the other has an area of 80 mm^2 and is used with a polyethylene radiator to detect neutrons in ^{252}Cf elution peaks. The preamplifier is packaged in a cylindrical container, and the input and output connectors are on the same end, simplifying the design of the lead shield and manipulation of the preamplifier in the hot cell. An alarm circuit is provided which is adjustable over the entire range of the rate meter producing a signal that can be used to control the process or to alert the operator of any desired level of radiation. The accuracy and repeatability of the alarm circuit is better than 1% in air conditioned buildings. (For details see TID-4100 Suppl 40) (F.S.)

32425 ALPHA SOURCE FOR EVALUATING ALPHA SURVEY PROBES /Q-2839/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1596).

2 drawings.

An alpha source assembly is described which is used in testing and evaluating α survey probes (such as described on drawing Q-2101 in CAPE-1131) for uniformity of the phosphor layer and quality of the optical coupling between the light pipe and the photomultiplier tube. The equipment also aids in making adjustments of the electronic sensitivity and photomultiplier tube voltage to achieve desired efficiency near the edges of the sensitive face of the probe. The assembly can test five positions of the sensitive face of the probe. (For details see TID-4100 Suppl. 40.) (F.S.)

32426 AUTOMATIC ELECTRODE LOADER AND POSITIONER FOR SPECTROGRAPH (Engineering Materials). (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). (CAPE-1585).

13 drawings.

The apparatus described automatically loads counter and crater spectrographic electrodes, positions both to a predetermined analytic gap, and automatically controls the analytic gap during burning. The maximum load is 40 samples. The apparatus consists of the following: a device for positioning the counter electrodes,

which are standard spectrographic electrodes; a device for positioning the crater electrodes, which contain the sample to be analyzed; a photoelectric device for controlling the analytic gap during burning; and an electronic control panel that provides variable analytic gap spacing and servo control during sample burning. (For details see TID-4100, Suppl. 40.) (F.S.)

32427 MODULAR ALPHA OR BETA-GAMMA RADIATION MONITORING SYSTEM /Q-3020/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1598).

4 drawings.

An α or β-α radiation monitoring system is described which consists of a transistorized model of the vacuum tube instrument described in CAPE-1048. The system conforms to AEC-NIM standards and is contained in a 5¼ in. NIM bin. The system consists of three linear count rate modules, three alarm modules, one 50 μA meter module, one 1mA recorder module, one audio module, and one 900 V detector high voltage supply. The linear count rate module, the alarm module, and the audio module are described. The count rate modules provide eight full-scale calibration ranges from 500 to 100,000 cpm and three integrating time constants of 1, 11, and 21 sec. High- and low-level alarms are adjustable over 100% of the calibration range. The system utilizes either a model Q-2101 α meter (See CAPE-1131) or a model Q-2152 G-M probe (see CAPE-1134). (For details see TID-4100 Suppl. 41.) (F.S.)

32428 ^{252}Cf NEUTRON COUNTER /Q-2841/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1608).

7 drawings.

A neutron counter is described which is used to count neutrons from samples containing ^{252}Cf. The counter utilizes ten proportional counters filled at a pressure of 80 cm Hf with BF_3 enriched to 96% ^{10}B. The sample to be counted is placed in an Al tube which is located in the center of a circle formed by the ten counters. The counters are contained in a polyethylene filled Cd screened mild steel case which fits into a polyethylene vessel with a square polyethylene top. A mild steel supplementary shield is supplied which is shielded with paraffin and boric acid. (For details see TID-4100 Suppl. 41) (F.S.)

32429 13TH NUCLEAR SCIENCE SYMPOSIUM INSTRUMENTATION IN SPACE AND LABORATORY, BOSTON, MASS., OCTOBER 19–21, 1966. IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 1-692(Feb. 1967). (CONF-661020).

Separate abstracts are prepared for 80 of the 94 papers presented. Fourteen papers were previously included in NSA. For abstract numbers of these papers see Conf 661020 in the report number index. (B.G.D.)

For abstracts of individual papers see: 32430–32476, 32488, 32503–32530, 32695, 33816, 33817, and 34172.

32430 LOW-ENERGY ELECTRON AND PROTON SATELLITE INSTRUMENTATION FOR AURORAL STUDIES. Reagan, J. B.; Carr, D. L.; McDaniel, J. D.; Sanders, T. C. (Lockheed Missiles and Space Company, Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 49-55(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

Several instruments employing variable-energy electrostatic thresholds and post-acceleration techniques in conjunction with plastic scintillator-photomultiplier detectors have been successfully used in a satellite experiment to measure low-energy electrons and protons in the auroral regions. A description of these instruments, which were designed to measure electrons in the energy range of 0.015 to 10.0 keV with detection sensitivities as high as 4×10^{-4} erg/cm^2-sec-sr and protons in the energy range of 0.20 to 10.0 keV with detection sensitivities of 6×10^{-3} erg/cm^2-sec-sr, is given. A discussion of the procedures employed in the laboratory calibration of these instruments is presented. In-flight calibration techniques involving both radioactive sources and programmable Ga-P light diodes are also described. The performance of the instruments during two satellite flights in November, 1963, and November, 1965, is illustrated by the presentation of some typical data. (auth)

32431 OGO-E COSMIC RADIATION: NUCLEAR ABUNDANCE EXPERIMENT. Jones, S. L.; Ludwig, G. H.; Stilwell, D. E.; Trainor, J. H.; Way, S. H. (Goddard Space Flight Center, Greenbelt, Md.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 56-63(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

Information on the detailed charge and energy spectra of galactic and solar cosmic rays is required for a better understanding of the production, acceleration, and modulation of those cosmic rays. This experiment consists of a set of three detector assemblies to measure the differential energy spectra of protons and heavier nuclei through calcium (Z = 20) in the range of 400 keV to 1 BeV/nucleon, and an extensive electronics system to implement the logic, perform pulse height analysis, measure particle fluxes, monitor experiment performance and interface with the OGO data system. (auth)

32432 A UNIQUE RADIATION DETECTION CONCEPT FOR A MINIATURE PARTICLE SPECTROMETER. Locker, Robert J. (General Electric Co., Philadelphia). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 64-9(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A three-channel particle spectrometer employing charge multiplying semiconductor detectors and tunnel diode discriminators has been constructed, environmentally tested and calibrated to detect low energy protons. The three channels have been calibrated to detect protons >0.5 MeV, >1.5 MeV, and >45 MeV. The instrument is five orders of magnitude more sensitive to protons than to electrons above 500 keV which ensures successful operation in the midst of electrons injected into the earth's radiation belt from the Starfish experiment. The unique features of this instrument are: discriminates uniquely against a low energy photon background, electric noise immunity due to the integration of the detector to the discriminator to give a high signal level output to the binary counter, and thermally generated noise does not compete with the detected signal at the discriminator. The miniature instrument is a result of simple detection circuitry and the use of microelectronic elements in the data compressor. The data compressor consists of three binary counters having a storage capability of 2^{18}-1 bits. Each counter has a thin film network to octally encode the binary counts into an analog voltage. The counters have a 1 MH_z count rate. The instrument design and its characteristics which reflect the design constraints of the flight vehicle are described. The calibration of the instrument for a small half-angle cone of low energy protons from a Van de Graaff accelerator is discussed. (auth)

32433 DIGITIZED SPARK CHAMBER FOR SPACE SCIENCE EXPERIMENTS. Ross, R. W.; Ehrmann, C. H.; Fichtel, C. E.; Kniffen, D. A. (Goddard Space Flight Center, Greenbelt, Md.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 78-82(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A digitized spark chamber was developed for gamma-ray and charged particle experiments on balloons and satellites. The spark chamber is assembled from modular units, which are stacked to the desired number of levels. Each module consists of parallel spark planes formed from two orthogonal wire grids. Ferrite memory cores, strung on the wires of both grids, record the x-y coordinate of the spark. Factors affecting the operating characteristics of these modules are discussed. A gamma-ray detector of 32 module levels was assembled and balloon-flown in a search for cosmic gamma-ray point sources. The construction of this detector is described and its performance briefly discussed. (auth)

32434 A HIGH PRECISION DC RESTORER. Chase, R. L.; Poulo, L. R. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 83-8(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The performance of high resolution pulse amplitude spectrometers is often seriously degraded at high counting rates due to base line problems of various kinds. A variation on the Robinson double-diode dc restorer is presented which makes it possible to obtain high resolution with Li-drifted Ge spectrometers at counting rates greater than 50,000 per second. (auth)

32435 ACTIVE D-C RESTORATION IN NUCLEAR PULSE SPECTROMETRY. Gere, E. A.; Miller, G. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 89-95(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

It is well-known that while the use of single clipping yields optimum energy resolution in nuclear pulse spectrometry it suffers from the drawback of producing rate-dependent base-line shifts. On the other hand the use of double clipping removes the base line shift but degrades the signal-to-noise ratio. A scheme was devised which circumvents some of these problems by producing a signal proportional only to the peak-to-peak excursion of an input signal. When operating with double clipped signals this improves the signal-to-noise ratio and also reduces tail-pile-up difficulties. Single clipped signals can also be used and produce an output amplitude which is independent of base line position, allowing the use

of single clipping at high counting rates, although in this case the system exhibits a noise disadvantage. The technique employed is based on the principle of active dc restoration and circuit details, together with representative results, are given. (auth)

32436 CHANNEL MULTIPLIER INSTRUMENTATION FOR THE MEASUREMENT OF LOW-ENERGY AURORAL PARTICLES. Shea, M. F.; Shook, G. B.; Reagan, J. B.; Smith, L. F.; Sanders, T. C. (Lockheed Missiles and Space Co., Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 96-102(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

Channel multiplier instruments were developed and used to measure the low-energy electron and proton auroral fluxes from a polar-orbiting satellite. Seven channel multipliers preceded by individual 90° magnetic analyzers were used to measure the differential electron energy spectrum. The central energies of the analyzers were 1.1, 2.1, 5.3, 14, 31, and 76 keV; the seventh channel was designed to be a background monitor. The integral proton number spectrum was measured using four channel multiplier threshold counters. Proton thresholds, determined by nickel foils, were chosen to be 21, 38, 56, and 1000 keV. A broom magnet was used to sweep out low-energy electrons. The saturated output pulses from each channel multiplier were amplified and fed into a logarithmic ratemeter. The in-flight operation of the instruments was monitored with low-level radioactive sources. The ratemeter calibration was independently monitored using a programmed pulser which was activated by ground command. Data obtained from these instruments during a three-day period in November, 1965, will be presented. Improved versions of these instruments, described herein, have been designed and tested for future flights. (auth)

32437 INSTRUMENTATION OF A STILBENE SCINTILLATION DETECTOR. Williamson, T. A. (Sandia Corp., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 103-9(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The electronic instrumentation of a stilbene scintillation detector which is used as a neutron spectrometer is described. In this application, the spectrum of scintillations caused by protons from (n,p) reactions must be measured and recorded for further analysis. The proton scintillations are separated from the electron scintillations by a double delay-line pulse-shape discriminator. The discriminating circuit also provides a linear, shaped output for pulse-height analysis. The unique features of this spectrometer are that the criterion for pulse-shape discrimination is well defined and easily optimized, and that the separated spectra of both types of ionizing particles are obtained simultaneously. (auth)

32438 A ZERO-CROSSING PULSE SHAPE DISCRIMINATOR FOR SPACE APPLICATIONS. Tietsch, R. A.; Kellogg, E. M. (American Science and Engineering, Inc., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 131-4(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A circuit for discriminating neutrons, gammas and charged particles from each other in a phoswich scintillator is described. The scintillator is intended for use as a fast neutron detector. Test results indicate that the particle discrimination capability, noise rejection, and pulse pile up rejection are good. The circuit is capable of operating with very little degradation over a wide temperature range. Energy information for neutrons and gammas is also simultaneously obtained. The dynamic range is at least 20:1. The circuit has the capability of accepting count rates up to 4×10^5 per second without loss of information. (auth)

32439 A MEDIUM FAST TIME-OF-FLIGHT FRONT END. Abel, L. C.; Fullwood, R. R.; Jones, J. A.; Moyer, W. R. Contract AT(30-3)-328. IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 162-9(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A medium fast time-of-flight front end for use with an on-line computer is described. Principal features of this unit are: 31.25 nsec minimum channel width, 1 μsec minimum deadtime, controllable deadtime (for synchronization purposes), 3 stage output derandomization buffer, simple low cost construction almost entirely of commercially available computer logic, crystal clock for stability, output pulse for clock synchronized accelerator triggering, 2^{20} channels available (1,048,576), 3 tag bits for data identification, and deadtime, clock livetime and lost data outputs. (auth)

32440 CAMPBELL THEOREM: SYSTEM CONCEPTS AND RESULTS. DuBridge, R. A. (General Electric Co., San Jose, Calif.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 241-6(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

Campbell's theorem states that the average value of the current from a source of random current pulses is directly proportional to the average pulse rate and the pulse height. It also states that the variance of the current from a source of random current pulses is proportional to the average pulse rate and the square of the pulse height. The various factors considered in designing a radiation detector system based on Campbell's theorem are discussed. The factors are charge generation in the detector, detector bandwidth, pulse rate, signal size, competing reactions, noise, detector saturation, statistical accuracy, time response, and nonrandomness. (B.G.D.)

32441 USE OF CAMPBELL'S METHOD IN NUCLEAR REACTOR CONTROL INSTRUMENTATION. Plaige, Y.; Quenee, R. (CEN, Saclay, Gif-sur-Yvette, France). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 247-52(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The measurement of statistical fluctuations from neutron detectors yields information proportional to the root mean square of the flux which is used in reactor control. The theory shows that neutron-gamma discrimination is improved by a factor 100 relative to a current measurement, when an uncompensated ionization chamber is used. Another advantage of this method is to have the possibility of connecting on the same detector two measuring channels (logarithmic and linear channel, for instance). An experimental logarithmic amplifier has been realized upon this principle. It operates over a three decade range (six decade flux range). Experimental results of measurements done on high flux experimental reactors are given. (auth))

32442 A NEUTRON FLUX MEASURING CHANNEL COVERING TEN DECADES OF REACTOR POWER WITH A SINGLE FIXED-POSITION DETECTOR. Trenholme, William M.; Keefe, Donald J. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 253-60(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A new type of instrument for neutron flux measurement in reactor control systems is described. It requires only a single fixed-position fission chamber of standard design to continuously cover ten decades of neutron flux level. The wide range of coverage is achieved by utilizing both the individual pulses from the chamber and the statistical fluctuation signal developed by the overlap of individual pulses. The channel provides a logarithmic indication of neutron flux level from approximately 1 nv to 1×10^{10} nv, with period indication over the range from approximately 1×10^4 nv to 1×10^{10} nv. It also provides a range-switched linear indication of neutron flux level over the range from approximately 1×10^4 nv to 1×10^{10} nv. (auth)

32443 A NEUTRON COUNTING SYSTEM WITH A FISSION DETECTOR AND A FLEXIBLE, BALANCED LINE. De Lorenzo, J. T. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 261-70(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A neutron counting system containing a fission detector and a pulse transformer driving a balanced transmission cable was investigated to determine its usefulness as an instrument for reactor control. Because of the noise rejection capability of the balanced system input, all active elements can be located away from the hostile environment of the reactor, resulting in longer periods of trouble-free operation. The design criteria of Fowler were used as a guide. The primary objective was to measure the response of the system to electrical interference characteristic of the Oak Ridge Research Reactor (ORR). The results showed no noise pulses in excess of the alpha threshold after six days of operation at the ORR. A detector without ^{235}U was used to make this measurement. The input cable, with a characteristic impedance of 250 ohms, was a 40-ft long double-shielded twisted pair. Its outer jacket and inner dielectric were made of irradiated polyolefin compounds. The cable was enclosed in a flexible, stainless steel conduit for underwater operation. The quality of the shield of this cable and four other types of balanced cables was determined by a measurement of their transfer impedance. To determine the effect of the flexible conduit, a separate measurement was made with the cable-conduit combination. The techniques required to make these measurements are critical and are described. The signal from the detector-cable combination requires a preamplifier with a low-noise input stage. A series-shunt feedback

stage using two 2N2857 transistors gave an input noise of approximately 2.8 nv/(cycle)$^{\frac{1}{2}}$ from 50 kHz to 30 MHz with a terminating resistor of 250 ohms. The common-mode rejection of the detector, pulse transformer, cable, and preamplifier circuit was measured from 20 kHz to 10 MHz both before and after a small modification to the system. The rejection after the modification was greatly improved, with a value of nearly 90 db at 20 kHz which decreased to slightly less than 40 db at 10 MHz. An overall effective transfer impedance was determined by correcting the transfer impedance of the cable-conduit for the effects of the improved common-mode rejection and the RC–RC filter of the amplifier (50 nsec in this case). The transfer impedance was 7×10^{-7} mv/amp-ft at 20 kHz which increased to 2×10^{-4} mv/amp-ft at 10 MHz. (auth)

32444 ^{16}N POWER CONTROL SYSTEM OF THE LIVERMORE POOL-TYPE REACTOR. Spracklen, Howard P. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 271-4(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A power level indicating and control system that is independent of rod position and gamma background was developed for the Livermore Pool-Type Reactor (LPTR). This system, based on the ^{16}N decay in the primary coolant water, avoids the errors in ion-chamber measurements caused by changes in leakage flux, related to fuel loading, fuel burnup, xenon buildup, and rod position. A scintillation detector was placed near the coolant outlet. A dual differential discriminator monitors the output and drives a counter in the control room. The numerical readout is directly in watts. The counter output provides a control signal that can override the ion-chamber control when an error exists. The system operates from 2 MW down to 2 kW under automatic control. (auth)

32445 UNDERWATER GAMMA RAY SPECTROMETERS FOR MONITORING ENVIRONMENTAL WATER AT NUCLEAR POWER STATIONS. Riel, Gordon K. (Naval Ordnance Lab., Silver Spring, Md.); Duffey, Dick. IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 275-8(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

An underwater gamma (γ) ray spectrometer was developed and used to measure the concentration of radioisotopes in water at the following sites: the Columbia and Savannah Rivers, the Ft. Belvoir, Peach Bottom, Indian Point, and Yankee power reactors and the University of Maryland Reactor pool. Concentrations of less than 10 picocuries per liter of reactor-produced isotopes were found at power reactor sites. The experience with this system and similar systems used at sea show that it can be adapted for use on a practical basis for continuous monitoring of environmental water. The detector used in these tests is discussed and an environmental monitor system for permanent installation is described. (auth)

32446 NUCLEAR TECHNIQUES IN NONDESTRUCTIVE TESTING. Jackson, Charles N. Jr. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 286-92(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

Gamma spectroscopy, alpha counting and x-ray fluorescence techniques have been developed and applied to testing nuclear reactor fuel elements. A gamma analyzer system incorporating a NaI(Tl) scintillator measures in a two minute counting period the enrichment level of the U-235 isotope over a 0.15 to 3.0 weight percent range with accuracy of about 0.1 percent. An alpha scintillation system, with unusually sturdy mechanical features to position heavy reactor fuel elements, detects uranium contamination at the 100 microgram level in a 10 minute counting period. A prototype x-ray fluorescence system detected uranium contamination in a weld zone over a 2-10 weight percent range in a small volume (0.25×10^{-3}in^3) at a scan rate of 5 in/min. These techniques and in particular x-ray fluorescence offer promising methods for testing impurity levels or alloying concentrations of space age components or materials. (auth)

32447 DESIGN CONSIDERATIONS FOR A SEMICONDUCTOR SANDWICH FAST NEUTRON SPECTROMETER. Rydin, Roger A. (EURATOM, Ispra, Italy). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 377-92(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

Semiconductor sandwich fast neutron spectrometers, using the ^{6}Li or ^{3}He reactions, are considered for use in measuring reactor type neutron spectra. Extensive digital computer calculations were performed in order to analyze the performance of these spectrometers. Areas treated were: response functions, detection efficiency and silicon background response. (B.G.D.)

32448 DIRECTIONAL NEUTRON SPECTROMETER. Tucker, Allen B. (Iowa State Univ., Ames); Lieber, Albert J. IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 402-5(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A detector capable of measuring the energy and direction of 1.0- to 15-MeV neutrons is described. The instrument consists of two conventional neutron detectors (organic scintillators and phototubes) and electronics which, for events in which a neutron is scattered by the first scintillator into the second, measures the energy of the recoil proton in the first scintillator and the time of flight of the scattered neutron between the two detectors. These two quantities determine the energy of the incident neutron and its direction relative to the line joining the two detectors. The response to a point source of 2.5-MeV neutrons is shown. (auth)

32449 DIRECTIONAL NEUTRON DETECTOR FOR ROCKET AND SATELLITE EXPERIMENTS. Kellogg, E. M.; Waters, J. R. (American Science and Engineering, Inc., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 406-13(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A directional neutron detector for the energy range 1.5 to 15 MeV was constructed. Its design is rugged enough to operate while under high mechanical stress, and at extremes of temperature. The detector is a liquid scintillator using glass capillary tubes to collimate proton recoils from elastic scattering of neutrons in the liquid. Gamma-rays are rejected by pulse shape discrimination, using a special circuit developed for space applications. (auth)

32450 MEASUREMENT OF THERMAL NEUTRON FLUX. Carter, R. S.; Muehlhause, C. O.; Myers, V. W. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 414-15(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A new technique was developed for the measurement of thermal neutron flux. Small glass beads (~1 mm radius) are made black to thermal neutrons by the inclusion of ^{10}B. In addition, a 1/v activation such as cobalt, dysprosium, or indium is incorporated in the glass to measure the fluence ($n\bar{v}t$). Following activation over a measured time interval, the absolute source strength of a Co bead is determined by γ-γ coincidence. The flux is directly proportional to the source strength. The Dy and In beads are calibrated relative to a Co bead. (auth)

32451 HIGH TEMPERATURE ^{3}He DETECTORS. Myers, John E. Jr. (Reuter-Stokes, Cleveland). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 416-21(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A ^{3}He detector was developed which is suitable for applications involving the detection of thermal and epithermal energy neutrons over an operating temperature range extending to above 200°C. The detector exhibits stable plateau characteristics for fill pressures of up to ten atmospheres in detectors of up to 1.75 inch diameter, and is resistant to degradation from thermal cycling and overtemperature operation. (auth)

32452 RECENT IMPROVEMENTS IN ^{3}He SOLID STATE NEUTRON SPECTROMETRY. Jeter, Thomas R. (Aberdeen Proving Ground, Md.); Kennison, Max C. IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 422-7(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A helium-3 semiconductor neutron spectrometer with enhanced efficiency and a useful energy range to 20 MeV is described. The efficiency has been increased 25 orders of magnitude over that previously attainable with only a small loss in resolution. Characteristics are presented along with typical monoenergetic and complex neutron spectra. (auth)

32453 PHOTOMULTIPLIERS FOR SCINTILLATION COUNTING IN SEVERE ENVIRONMENTS. Helvy, F. A.; Matheson, R. M. (Radio Corp. of America, Lancaster, Pa.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 433-7(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A new family of photomultipliers suitable for scintillation counting in severe environments was developed. These tubes provide performance equal or superior to that provided by the best types of non-rugged tubes. The electron-optical and mechanical design is described with particular emphasis on those properties that ensure

good performance in severe environments. Mechanical tests of tube ability to survive severe vibration and shock are described, and operating characteristics during vibration are evaluated. The electric properties required in scintillation counting were measured, and pulse-height resolution and dark-noise characteristics were determined. Several variants suitable for special applications were built. (auth)

32454 RESOLUTION AND CATHODE UNIFORMITY IN SCINTILLATION COUNTERS. Takhar, P. S. (Royal Military Coll. of Canada, Kingston, Ont.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 438-42(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

An investigation of photocathode uniformity using a pulsed light-source and a special type of source holder was carried out with a multichannel analyzer. The sensitivity profiles of uniformity of the photocathode of a two-inch 14-stage photomultiplier at various focussing control voltages are presented in a number of contour maps. The variation of sensitivity along major and minor axes of the photocathode as a function of focus voltage has been investigated. An attempt is made to relate scintillation counter resolution to nonuniformity of the photocathode. (auth)

32455 A SOLID STATE SCINTILLATION DETECTOR. Wilcox, George E. (Naval Air Development Center, Warminster, Pa.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 460-3(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

Efforts to substitute a solid state device for the usual photomultiplier of a scintillation type nuclear detector led to the photoconductive cell. Although extremely sensitive, cadmium sulfide responds slowly to low levels of light, and a technique providing improvement over several orders of magnitude failed to achieve measurement of individual pulses. In an integrating application, however, such a method makes possible a simple, reliable, and inexpensive instrument for measuring alpha, beta, gamma, and neutron dose rates over a wide range of operation. (auth)

32456 SODIUM ACTIVATED CESIUM IODIDE AS A GAMMA RAY AND CHARGED PARTICLE DETECTOR. Menefee, J.; Cho, Y.; Swinehart, C. (Harshaw Chemical Co., Cleveland). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 464-7(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The pertinent physical properties of CsI(Na), including refractive index, optical transmission, and fluorescent emission characteristics, are summarized and the gamma-ray mass absorption coefficients calculated from elemental cross sections are presented. Single crystal ingots up to ten-inch diameter have been grown and data obtained from these crystals are reported. These data include relative pulse heights, linearity of response, resolution as a function of gamma energy, emission decay constant, response to alpha and beta, and the relative pulse height as a function of temperature from −60 to +160°C. (B.C.D.)

32457 THE FLUORESCENT RESPONSE OF NaI(Tl), CsI(Tl), CsI(Na) AND CaF_2(Eu) TO X-RAYS AND LOW ENERGY GAMMA RAYS. Aitken, D. W.; Beron, B. L.; Yenicay, G.; Zulliger, H. R. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 468-77(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The fluorescent response functions of NaI(Tl), CsI(Tl), CsI(Na) and CaF_2(Eu) were determined with thin crystals over the energy range from 3.3 keV to 840 keV. A pronounced nonlinear dependence on photon energy was observed in this region for all four types of crystals investigated. Qualitatively the response functions for NaI(Tl), CsI(Tl) and CsI(Na) are similar down to a photon energy of about 20 keV, but major differences are observed at lower energies. The response function of CaF_2(Eu) is very different from the response functions for the other three crystals over the entire energy range examined. Both K-shell and L-shell absorption edge discontinuities are evident in the fluorescent response curves for Na(Tl) and CsI(Tl). Only K-shell absorption edge discontinuities could be observed in the response curves for CsI(Na) and CaF_2(Eu). A nonlinear fluorescent dependence on electron energy is indicated for all four types of crystals. Discontinuities in the spectral resolution function are observed in NaI(Tl) at energies corresponding to both the K-shell and L-shell absorption edges of iodine. A shift toward longer wavelengths in the light spectrum emitted by NaI(Tl) in response to excitation by x-rays with energies below about 10 keV may also be indicated by photomultiplier-dependent differences observed only at the lowest energies. (auth)

32458 STUDIES ON NOBLE GAS SCINTILLATORS. Hench, R.; Coche, A. (Centre de Recherches Nucleaires, Strasbourg). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 478-86(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The results from a study of the use of noble gases without wavelength shifters as scintillation detectors for nuclear particles are presented. The spectra and the time dependence of the fluorescence induced by α particles in helium, neon, argon, krypton and xenon were investigated by single photoelectron techniques and are reported. A study of the scintillation efficiency as a function of gas pressure and of dimensions of the scintillation chamber shows the great importance of geometrical factors in light collection. In all cases, experimental results on pulse heights and decay times would be reproduced within ±5% and the operation of these gas scintillators as particle detectors was found to be satisfactory. (auth)

32459 NOISE, TRAPPING AND ENERGY RESOLUTION IN SEMICONDUCTOR GAMMA-RAY SPECTROMETERS. Day, R. B.; Dearnaley, G.; Palms, J. M. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 487-91(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The relative importance of noise, trapping, and recombination of carriers in determining the overall energy resolution of semiconductor gamma-ray spectrometers are considered. In particular a detailed analysis of the effects of trapping is presented. The model used derives from an earlier study by Northrop and Simpson, but some approximations made in their analysis, which are quite important under practical conditions, were eliminated. Relationships are derived between the total signal charge, its mean square deviation, and the drift lengths of electrons and holes in a planar detector. The results show that very stringent conditions are necessary in order to achieve the energy resolution which has been reported in some instances. It is shown that electron and hole drift lengths should be as closely equal as possible in a good detector. A uniform geometry, either wholly planar or wholly coaxial, is shown to be desirable. (auth)

32460 PRODUCTION OF LITHIUM DRIFTED GERMANIUM DETECTORS BY AC DRIFT. Jamini, M. A. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 492-502(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

Thick planar detectors were produced by ac drifting. Lithium is diffused on two opposite surfaces of a p-germanium block, thus producing an n^+pn^+ structure with two diodes back to back. Drift then proceeds from the two surfaces on alternate half cycles of the ac field. When the two compensated regions meet, one n-contact is removed and replaced by a p-contact. Any remaining uncompensated regions are then compensated by a dc drift. The p-contact is produced by diffusing gallium-indium eutectic at 400°C. By this technique it is possible to drift as deep as 2 cm and thus to produce a large volume detector with low capacitance. (auth)

32461 THE ANNULAR LITHIUM-DRIFTED GERMANIUM DETECTOR AS A STANDARD-GEOMETRY GAMMA SPECTROMETER. Levy, A. J.; Ritter, R. C.; Ziock, K. (Univ. of Virginia, Charlottesville). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 509-13(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

Lithium-drifted germanium detectors were fabricated in the form of a cylindrical annulus. The forming of the annular shape was made feasible by using a spark cutting machine. The annular shape, being highly symmetrical, permits standardization of the techniques of gamma spectroscopy. (auth)

32462 LARGE, MULTIPLE ELEMENT GERMANIUM SPECTROMETERS. Lalovic, B.; Azuma, R. E.; Petrovic, B. (Univ. of Toronto, Ont.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 514-20(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

Large coaxial Ge(Li) diodes were assembled in multiple arrays in one cryostat in order to provide spectrometers of very large sensitive volumes. A double element and a four element spectrometer are described in detail. The latter spectrometer has a total sensitive volume of 180 cm^3. The efficiencies and resolutions of the spectrometers were measured for various combinations of diodes and summing procedures. In the optimum arrangement for the four element spectrometer, a resolution of 15 keV at 1.33 MeV was obtained, and the full energy efficiency was found to be equal to one quarter of that for a 3″ × 3″ NaI(Tl) scintillation counter. An efficiency curve for the two element spectrometer for energies up to 10 MeV is presented. (auth)

32463 ENCAPSULATED COAXIAL Ge(Li) DETECTORS OPERATED IN PARALLEL. Malm, H. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 521-2(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The parallel operation of up to four large coaxial lithium-drifted germanium gamma spectrometers was analyzed in order to ascertain whether an increase in overall efficiency can be obtained. (B.G.D.)

32464 EFFECTIVE WINDOW OF SILICON SURFACE BARRIER COUNTERS. Siffert, P.; Forcinal, G.; Coche, A. (Centre de Recherches Nucleaires, Strasbourg). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 532-6(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The window of surface barrier detectors is an important source of error in energy measurements for protons and heavier ions. Two methods were used to measure the thickness of this window. In the first the pulse height defect was measured for protons and deuterons as a function of the particle energy. The results show that the window includes the gold layer plus a dead region of silicon (or oxide), the thickness of which depends upon the applied bias. In the second method, the detector was used as a photodiode, and the absorption of light at values of wavelength between 0.4 and 0.6 μ was measured. The values of thickness ($\simeq$1000 Å) of the dead region in silicon obtained by these two methods are in good agreement. During a study of nuclear collisions with low energy heavy particles in silicon, it was noticed that the existence, under the gold layer (thickness Δx_1), of a dead region with a thickness Δx_2 was possibly greater than 0.1 μ. In order to get more precise information on this window, the response of surface barrier detectors exposed to protons and deuterons with energies between 20 and 150 keV and light at values of wave-length from 0.3 to 0.6 μ were studied. (B.G.D.)

32465 SURVEY OF MATERIALS FOR RADIATION DETECTION AT ELEVATED TEMPERATURES. Prince, M. B. (Electro-Optical Systems, Inc., Pasadena, Calif.); Polishuk, P. IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 537-43 (Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A survey was made of wide-band gap, high atomic number semiconductor materials to determine those suitable for radiation detectors in military and space applications. The operating parameters studied were temperature range, counting rate, depletion depth, device area, and effective Z. Based on the requirements, the best materials considered were CdTe, GaP, CdSe, and ZnTe. (B.G.D.)

32466 A PAIR SPECTROMETER USING A LARGE COAXIAL LITHIUM-DRIFTED GERMANIUM DETECTOR. Orphan, V. J.; Rasmussen, N. C. (Massachusetts Inst. of Tech., Cambridge). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 544-58(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A gamma-ray spectrometer, using a 30 cc coaxial Ge(Li) detector, which can be operated as a 3 crystal pair spectrometer at high energies and in the Compton suppression mode at low energies, provides an effective means for studying complex gamma spectra. Pair spectrometer operation enhances peak to background ratios by reducing background and eliminating single escape and full energy peaks. The peak to background ratio for the 2.614 MeV gamma of ^{208}Tl is improved by about a factor of 70 with only a factor of 7 loss of efficiency. The energy resolution (fwhm) of the spectrometer is approximately 0.5% at 1 MeV and 0.1% at 7 MeV allowing capture gamma energies to be determined to an accuracy of about 1 keV. A comparison is given of the performance of the pair spectrometer using two smaller Ge(Li) detectors (3 cc and 5 cc) and the large 30 cc detector. Capture gamma spectra of Ti and Zr are given to illustrate the performance of the spectrometer. (auth)

32467 THE LINEARITY OF THE CHARGE CONVERSION FUNCTION FOR COOLED LITHIUM-DRIFTED SILICON DETECTORS IN RESPONSE TO X-RAY AND LOW ENERGY GAMMA RAY EXCITATION. Zulliger, H. R.; Aitken, D. W. (Stanford Univ., Calif.). Contract AF49(638)-1499. IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 563-8(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The linearity of the collected charge/keV was determined as a function of energy between 4.9 and 75 keV for cooled lithium-drifted silicon detectors. Nonlinear effects for applied field intensities up to 1 kV/cm have been observed to extend to photon energies above 30 keV. Extrapolation to infinite fields does not remove the nonlinear effects for photon energies below 10 keV, indicating an intrinsic nonlinear response at low energies. The charge conversion factor appears to be independent of energy within 0.2% down to 10 keV. (auth)

32468 P-N SEMICONDUCTOR DETECTORS FOR SEVERE ENVIRONMENTAL CONDITIONS. Wilburn, C. D.; Mallamo, R. (Simtec Ltd., Montreal). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 569-75(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

Fabrication technology and characteristics of totally depleted radiation detectors prepared by planar techniques are described. These devices prepared from p-type silicon with resistivities from 500 to 50,000 ohm-cm received a boron diffusion, an oxidation step and a phosphorus diffusion step. All contacts utilize ultrasonic bonding. The devices operate as detectors over the temperature range 77°K to 150°C. Detailed performance of these units will be presented. (auth)

32469 POTENTIAL OF SMALL DIGITAL COMPUTERS FOR ANALYZING NUCLEAR SPECTROSCOPY DATA. Black, W. W.; Heath, R. L. (Idaho Nuclear Corp., Idaho Falls). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 591-8(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The development of larger, more accurate analog-to-digital converters and high resolution detectors has given rise to many new problems in the acquisition and analysis of data. Examples are presented of how these problems have been approached using a small computer (DEC PDP-8). Although the examples to be presented deal with gamma-ray spectra, the techniques used should be applicable to beta or particle spectra. The major problems presently associated with the analysis of gamma-ray spectra are centered around the large volumes of data accumulated in a typical experiment. Large amounts of time elapse when these data are analyzed on a large computer in a batch-type operation. The time loss is not in the actual computing time, but in the formating of data, large turn-around times, and correlating information in listings and plots of the data. All of these bottlenecks have been either substantially reduced or eliminated by using the small computer connected to an oscilloscope and light pen. The spectrum is stored in the computer memory and can be displayed and manipulated in many different ways by using sense switch operations plus the concept of an electronic keyboard on an oscilloscope. This system allows an experimenter to determine transition energies, photopeak intensities, etc. in one setting as opposed to time lapses of as great as two weeks under previous conditions. Thus delays due to turn-around times, listing and plotting, and correlating information on the lists and plots have been eliminated. The hardware and software techniques which have been developed to implement the light pen-electronic keyboard concept will be presented. Application of this concept to actual data analysis making use of functional displays will be discussed. (auth)

32470 A VERSATILE SATELLITE DATA-HANDLING SYSTEM FOR SPACE RADIATION MEASUREMENTS. Reagan, J. B.; Reed, R. D.; Bakke, J. C. (Lockheed Missiles and Space Co., Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 620-5(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A highly versatile digital data-handling system which can be utilized with any existing telemetry was designed to specifically accept and control the output of a scintillation spectrometer. The system utilizes a 64-channel pulse-height analyzer in conjunction with a rate-accumulator for the determination of the spectrum and flux of the radiation to be measured. Random input data from the detector are sampled by the pulse-height analyzer and periodically presented to the telemetry at a rate which is consistent with the available bandwidth. Absolute counting-rate information for rates up to 10^6 counts/sec as measured by the rate-accumulator is merged with the spectrum data into a common serial output under the control of a master clock. Synchronization patterns are introduced periodically to make the resulting pulse-coded wavetrain recognizable to automatic computer-compatible processing equipment. Coded time information is also introduced periodically when the system is used in conjunction with a satellite tape recorder. A detailed description of the system and its operation with all of the telemetry systems in general use is presented. A description of an economical decoder for field processing of the data from the system is also given. Finally, the use of an automatic computer-oriented data-processing system for handling flight data from the digital spectrometer is described. (auth)

32471 ON-LINE TRANSFORMATIONS OF HIGH RESOLUTION SPECTRA. Wyckoff, James M. (National Bureau of

Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 634-9(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A new technique was devised for transforming the pulse height distribution obtained from a lithium–drifted germanium crystal used as a gamma-ray spectrometer into an energy, peak area vector. The computer operations required are simple enough to be performed by an on-line computer in about five seconds. The vector is generated from the raw pulse height distributed by the subtraction of a smoothed version of the raw vector. In order to remove the statistically insignificant portions of the differences, all values less than twice the square root of the original element of the data are set equal to zero. The only remnant of the Compton contribution to the raw data is a small peak at the Compton edge. The resulting vector may be plotted directly or further transformed to sum the area under each peak providing a convenient graphic or tabular means of presenting the gamma-ray energy and relative intensity information. (auth)

32472 ANALYSIS OF THE NUMERICAL METHODS FOR THE UNFOLDING OF BETA SPECTRA OBTAINED BY INTEGRAL DETECTORS. Di Cola, G.; Rota, A.; Bertolini, G. (CCR-EURATOM, Ispra, Italy). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 640-53(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The beta spectrum, obtained by solid state or scintillation spectrometers, cannot be considered the true spectrum, due to the resolution and backscattering characteristics of the detectors. The true shape can be obtained from the experimental one by solving a Fredholm's integral equation of the first kind, having as kernel the response function of the spectrometer. From the mathematical point of view this is an incorrectly posed problem. A critical analysis on some usual numerical methods is presented, under the assumption of uniqueness of the solution. The replacement of the equation with a linear algebraic system is obtained by some quadrature formulas. Despite the formula used, the system is essentially illconditioned. The most currently used methods for linear system solutions are examined. The splitting of the response matrix in the product of the two matrices (resolution and back scattering), as suggested by D. D. Slavinskas et al., appears a very useful tool. A block direct method, due to the block tridiagonal form of the resolution matrix, and a block iterative method are applied; direct inversion is suitable for the triangular matrix of the backscattering. The standard error on the unfolded spectrum, due to the standard error on the experimental spectrum and to the response function parameter uncertainties is examined. (auth)

32473 AUTOMATIC DATA PROCESSING FOR DIGITAL AUTOFLUOROSCOPE SCINTILLATION CAMERA. Spergel, Philip (Baird-Atomic, Inc., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 672-82(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A digital autofluoroscope was designed with an internal special-purpose data processing system to provide the operator with automatic computation of the accumulated data. The computer will automatically do background subtraction, data averaging, and section integration. The accumulated data are then stored on magnetic tape so further processing can occur either on the autofluoroscope console or on an off-line computer. The display of data and further means of data reduction and storage are explained. (B.G.D.)

32474 SPECULAR REFLECTIONS IN SCINTILLATION FRUSTUMS. Weiner, Melvin M. (Edgerton, Germeshausen and Grier, Inc., Boston). Contract AT(29-1)-1183. IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 686-92(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A method of analysis previously developed by Williamson for calculating the light output of conical light pipes is extended to end-window scintillators whose surfaces are specularly reflecting. If the larger base of the scintillation frustum adjoins a photodetector of greater index of refraction than the scintillator, all of the generated light can be collected in four or less reflections for a wide range of frustum geometries. Light collection properties are tabulated as a function of tapering angle, ratio of base diameter to altitude, and surface reflectivity with an accuracy of better than 80% over a wide range of parameters by assuming all of the light to be generated at the center of the median altitude. (auth)

32475 COINCIDENCE RESOLVING TIME IMPROVEMENT BY ENERGY-TIME CORRELATION. Mollenauer, James F. (Bell Telephone Labs., Inc., Murray Hill, N. J.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 604-7(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

In particle-particle coincidence experiments with semiconductor detectors, the chief limitation on resolving time often lies in the time required for charge collection, particularly if the energy ratio of the two detected particles varies over a wide range. However, the penetration depth of the particles and hence their collection time is a function of their energy. By measuring the arrival time difference for the two coincident signals, one may compare the timing with the energy and select only those events whose timing is appropriate to their energy. The time measurement has been carried out by using fast circuits to provide time-overlap signals, digitized into a few channels by a stacked discriminator. This information, along with the digitized energy signals, was fed to an on-line SDS 910 computer, which selected events according to a previous time-energy calibration. This calibration method was strictly empirical: the time and energy were initially recorded for all time channels simultaneously. On the basis of these data different parts of the kinematic line were assigned with a light pen to appropriate time channels, overlapping where necessary. The initial application of this method to the reaction $^{1}H(d,2p)n$ where the particle energies varied over a 20 to 1 range resulted in a factor of 3 improvement in the original 75 ns resolving time, using only 4 time channels. Twelve additional time channels now available should result in considerable further improvement. This method is complementary to any collection-time improvement by detector cooling and should continue to work until the timing is limited by noise or device inhomogeneity. Furthermore particle flight time variations are compensated equally easily; for heavy-ion experiments now in progress these variations would require a minimum resolving time of 30 ns without the use of this correlation technique. (auth)

32476 ASSAY OF LUMINESCENT BORAZINE AND BORAZARENE DERIVATIVES AS SLOW NEUTRON SCINTILLATORS. Molinari, M. A.; Rojo, A. E.; Videla, G. J. (Comision Nacional de Energia Atomica, Buenos Aires). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 393-401(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

N-trimethyl B-tri(diphenyl), N-triphenyl B-tri(diphenyl), N-triphenyl B-tri(alpha-naphthyl) borazines, and hydroxiborazaro phenanthrene and bis-2-1-borazaro-2-naphthyl ether, were assayed in benzene solution and as solid films for scintillation counting of thermal neutrons moderated with paraffin from the reaction $^{7}Li(d,n)^{8}Be$. A background of gamma radiation was present, partly from the reaction $^{7}Li(p,\gamma)^{8}Be$. Absolute gamma and neutron flux measurements of the source were made, using gamma ray spectrometry and foil activation. Characteristic counting curves and absolute counting efficiencies were obtained for several liquid and solid scintillators. Also, studies of the concentration effects, geometrical and dimensional factors, etc., were made using a Po–Be and a Ra–Be source and several gamma ray sources. Finally, actual tests based on the aforementioned experiments were made in a nuclear critical facility and excellent results were obtained. (auth)

32477 PREAMPLIFIER /Q-3016/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1612).

3 drawings.

A preamplifier which is used in a fast counting system is described. The preamplifier with an input from a pulse generator has a voltage gain ≈10 into a 50 ohm load. It is contained in a Cu shield which is gold flashed after fabrication. The preamplifier is used in AEC-NIM 8¾ in. bin. (For details see TID-4100 Suppl. 41) (F.S.)

32478 IONIZATION CHAMBER SURVEY METER /Q-2898/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1597).

1 drawing.

A transistorized survey meter is described which replaces a vacuum tube instrument. The instrument has full-scale sensitivity ranges of 10r/hr, 1r/hr, 100mr/hr, and 10mr/hr. The circuit comprises a 500-cm^3 ionization chamber coupled to a transistorized current-feedback differential amplifier having an open loop gain between 30 and 50. A dc-to-dc converter supplies required potentials of +15V and –10V for the amplifier stage and +110V for the saturation potential of the ionization chamber. Power for the converter is obtained from two 1.5V "D" cell batteries. (For details see TID-4100 Suppl. 40) (F.S.)

32479 DC TO DC CONVERTER FOR ION CHAMBER SURVEY METER /Q-2879/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1471).

1 drawing.

A dc to dc converter is described which supplies the required

potentials of +15V and −15V for the amplifier stage and +110V for the saturation potential of the transistorized Ionization Chamber Survey Meter Q-2898 (See CAPE-1597). The converter has an efficiency of ~80%. Power for the input to the converter is obtained from two 1.5V standard "D" cell batteries. (For details see TID-4100 Suppl. 40). (F.S.)

32480 AIR PROPORTIONAL ALPHA SURVEY METER /Q-2912/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1592).
2 drawings.

An α survey meter for use with an air proportional probe is described. The meter includes a positive 1725V 60μ A dc power supply, discriminator, voltage amplifier, and a charge sensitive amplifier. (For details see TID-4100 Suppl. 40). (F.S.)

32481 G-M TUBE TEST CIRCUIT /Q-2903/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1591).
3 drawings.

A test circuit is described which eliminates the need for a complicated pulse amplitude requirement in G-M tubes. The circuit determines incompatibility between G-M tube performance and instrument circuit design in civil defense instruments. (For details see TID-4100 Suppl 40). (F.S.)

32482 GASEOUS ACTIVITY MONITOR /Q-2325/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1604).
1 drawing.

A detector is described which is part of the γ-radiation monitoring system installed in the HFIR stack at a height of 50 ft. The end window type Geiger–Mueller tube used in the system indicates radiation levels up to 25 mr/hr. Input of gas is from a trap which removes iodine from the gaseous sample. The Lionel 210T Geiger–Mueller tube is mounted in a stainless steel gas flow detector. (For details see TID-4100 Suppl. 41). (F.S.)

32483 AERIAL SURVEY METER /Q-2920/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1600).
1 drawing.

An aerial survey meter is described (designated CDV-781) which is installed in an aircraft. When flown at low altitudes over a radioactive area the meter indicates the ~ intensity of radiation at ground level. The detector system consists of three linear count rate meters and three G-M tubes (each of a different size and sensitivity). (For details see TID-4100 Suppl. 41). (F.S.)

Radiation Dosimeters

32484 (USNRDL-TR-67-56) LITHIUM FLUORIDE FOR MEGARAD DOSIMETRY. Goldstein, Norman; Miller, William G.; Tochilin, Eugene (Naval Radiological Defense Lab., San Francisco, Calif.). May 26, 1967. 12p.

A LiF dosimeter has been developed to measure gamma-ray exposures between 10^5 and 2×10^9 R. Applicability of the LiF as a megarad dosimeter depends on the fact that a thermoluminescent glow peak at a temperature about 450°C has a negligible response to radiation below exposures of 10^5 R. A number of crystal specimens were examined and most of them were found to have the high temperature glow peak which could be followed as a function of exposure for three to five decades. Similar responses of the high temperature glow peak were found for the dosimeter when exposed to 2-MeV pulsed electrons or thermal neutrons. (auth)

32485 (AEC-tr-6719) DOSIMETRY AND RADIATION PROTECTION. COLLECTION NO. 4. Kimel, L. R. (ed). Translation of Vop. Dozimetr. Zashch. Izluechenii, Moskov. Inzh. Fiz. Inst. Sb. Statei, No. 4, 1965. 124p. (IPST-Cat.-1825). Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $10.10 fs, $3.92 mf.

Separate abstracts were written for the 23 papers included in this collection. (S.F.L.)

For abstracts of individual papers see: 32275, 32373–32384, 32501, 33502–33508, 33813, and 33860.

32486 MATRIX METHOD FOR THE EVALUATION OF BETA-GAMMA DOSIMETER FILM. Kirchner, R. A.; Ryan, T. L. (Dow Chemical Co., Golden, Colo.). Health Phys., 13: 810-11(July 1967).

Because of the energy dependence of photographic film, it is necessary, for proper dose evaluation, to separate the radiations into various energy groups. This separation is especially important for energies around 50 keV where the relative response of the film may be 15-20 times greater than for energies of 0.4 MeV and higher. Energy separation can be accomplished by the use of filters which selectively transmit/attenuate radiations in the desired range. If, as in the case of plutonium radiations, it is necessary to identify more than two energy groups, determination of dose becomes complex and prone to inaccuracies. If film evaluation of beta radiation is used, the separation of hard gamma, soft gamma, and beta presents the same problems as separations of three gamma (x ray) components. The problem is one of simultaneous solution of three or more equations. The solution to these equations can be performed graphically if certain assumptions concerning transmissions through the various filters are made. For a 3-component system, the graphical solution is time-consuming and the transmission assumptions can lead to significant errors. For a 4-component system an accurate graphical solution is practically impossible. These factors emphasize the desirability of a simplified computer program to solve the dose equations. Ideally, the density under the various filters would be used as the input and the true dose (by energy group) would be the computer output. A system for evaluating plutonium gamma and beta is described. (auth)

32487 CORRECTION TO ARTICLE "METHOD FOR CALCULATIONS EFFICIENCY OF RADIATION APPARATUS WITH PLANE GAMMA-SOURCE." Makhlis, F. A.; Breger, A. Kh. At. Energ. (USSR), 22: 237-8(Mar. 1967). (In Russian).

A method was suggested previously (Atomnaya Energiya 19, 193, 1965) for calculating the efficiency of radiochemical devices with plane γ radiation sources. However, an error was found in the numerical integration in the table for the magnitudes $\phi'[(a/\gamma, b/\gamma, \gamma)(d + y + h)] \times 10^3$. Moreover, the table constructed for the function $\phi(b/h, a/h, \gamma d)$ was not taking into account the radiation absorption in media with various γ magnitudes and at various distances from the plane of the radiation source. Corrected calculations are presented. (R.V.J.)

32488 SEMICONDUCTOR FAST-NEUTRON DOSIMETER WITH LOW THRESHOLD OF SENSITIVITY. Kramer, Gordon (Battelle Memorial Inst., Columbus, Ohio). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 365-71(Feb. 1967).
From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A lithium-drifted silicon fast neutron dosimeter with a low threshold of sensitivity is described and compared with an earlier version of the device (IEEE Transactions, NS-13(1), 104 (Feb., 1966)). (B.G.D.)

32489 RUBY AS A THERMOLUMINESCENT RADIATION DOSIMETER. Philbrick, C. R. (North Carolina State Univ., Raleigh); Buckman, W. G.; Underwood, N. Health Phys., 13: 798-801(July 1967).

A study of the thermoluminescent properties of ruby (Al_2O_3: Cr^{3+}) is described and comparisons were made with properties of sapphire (Al_2O_3) and LiF. Results indicated that ruby possesses characteristics which compare very favorably with other available thermoluminescent materials. The glow curve of ruby showed one prominent peak at 350 to 400°C shifting slightly to lower temperatures with increasing radiation exposure. The main advantage of ruby over LiF is a larger thermoluminescent yield and greater thermal stability. The emission of ruby occurs in a broad band around 7000 Å, with strong Cr R-lines. Light bleaching effects were not observed in normal room light. Reproducibility was good and handling easy. (UK)

32490 ABSOLUTE NEUTRON DOSIMETER BASED ON A GENERALIZED CONCEPT FOR RADIATION DOSIMETRY. Davy, D. R.; Peshori, L. H. (Oak Ridge National Lab., Tenn.). Health Phys., 13: 783-94(July 1967). (ORNL-P-2008).

The neutron dosimeter described is based on a generalized concept of radiation dosimetry, the interaction products being recoil protons from a hydrogenous radiator and the energy loss distribution considered being that from the protons passing into or through a surface barrier radiation detector. Because it is based on a generalized concept, this dosimeter has the characteristics of an absolute instrument whose characteristics can be fitted to any dosimetry concept and can be used as a dose spectrometer. Three dose concepts are considered: kerma in tissue, first collision dose in tissue, and surface multicollision dose for a 30-cm slab of tissue. Results are presented for each of these concepts in terms of dose per unit neutron fluence for Pu–Be, Am–Be, Am–B and fission neutron sources. The differences between these and reported results obtained with other dosimetry systems are discussed in terms of the absolute errors of each method of measurement. (auth)

32491 USE OF FLUOROCARBONS FOR CHEMICAL DOSIMETRY IN NUCLEAR REACTOR RADIATION FIELDS. Proksch, E. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). Atompraxis, 13: 190-1 (Apr.-May 1967). (In German).

It was proposed that the formation of CF_4 from suitable fluorocarbons combined with the H_2-production from cyclohexane be used for the simultaneous determination of gamma- and fast neutron doses. Both measurements were easily performed by gas chromatography. As examples, two commercial Perfluorokerosene

mixtures were investigated. After purification, both mixtures showed $G(CF_4)$-values that were sufficiently reproducible and slightly dependent on dose. When used for in-pile dosimetry satisfactory agreement was found with calorimetry. (auth)

32492 USE OF IONIZATION CHAMBERS FILLED WITH A DIELECTRIC LIQUID IN RADIATION DOSIMETRY. Ladu, M.; Pelliccioni, M. (CNEN, Rome). Nucl. Instrum. Methods, 53: 35-40(July 1967).

The response to γ-rays and neutrons of an ionization chamber filled with hexane in function of various parameters (interelectrode distance, collecting voltage, dose rate) was studied in order to realize a dosimeter which would take advantage from the ionization in liquids. A comparison was also made with the response of the same chamber filled with air. From the results obtained, the employ of ionization chambers filled with dielectric liquid seems particularly promising in dosimetry. (auth)

32493 ABSORBED DOSE MEASUREMENTS WITH A PORTABLE CALORIMETER. Goldstein, N.; Schleiger, E. R.; Tochilin, E. (Naval Radiological Defense Lab., San Francisco). Health Phys., 13: 806-9(July 1967).

The design and calibration of two portable calorimeters and subsequent measurements made with pulsed and steady state x-ray generators, gamma-ray sources and 900-MeV alpha particles are described. The construction of the calorimeters is based on a prototype previously described in which boiling liquid nitrogen establishes an isothermal environment and a thermal switch permits rapid cooling of the detector. The two versions are identical except that one has a beryllium absorber and the other a carbon-loaded plastic absorber. The calorimeters weigh about 10 kg and have a radiation probe 10 cm long and 6.4 cm in diameter. Less than half a day is required to prepare the calorimeter for exposure to temperature rises corresponding to 20 rads of absorbed energy and an overnight period is usually enough for an exposure of the order of a rad. The preparation consists of adding liquid nitrogen to the reservoir and cooling the absorber by means of the thermal switch. The absorber is cooled to the temperature at which the detecting thermistor shows a negligible change with time. (auth)

32494 THERMAL ANNEALING EFFECTS ON THE THERMOLUMINESCENCE OF LITHIUM FLUORIDE TEFLON DISC DOSIMETERS. Webb, G. A. M. (Central Electricity Generating Board, Berkeley, Eng.). Health Phys., 13: 814-16(July 1967).

It is important in thermoluminescent dosimetry that there should not be significant shallow traps present in the phosphor. A study of thermal annealing effects on loose powder LiF phosphors indicated that this could be achieved by annealing for 1 hr at 400°C, followed by heating for 24 hr at 80°C. The purpose of the 400°C treatment is complete de-excitation of all traps in the phosphor, and the 80°C treatment causes the trap distribution to approximate best to the desired single peak glow curve. One of the difficulties in the use of Teflon as binder when incorporating LiF powder into a solid matrix is that it will not withstand 400°C. The manufacturer's recommended high temperature annealing is 15 min at 300°C, which appears satisfactory for de-excitation, but the recommended subsequent annealing at 80°C is only for 2 hr. This may involve errors attributable to a low temperature peak in the glow curve. An attempt is described to eliminate this effect. It was found that if the Teflon disc dosimeters were annealed for 15 min at 300°C, followed by 24 hr at 80°C, they gave a glow curve very similar to the loose LiF powder phosphor. (UK)

Radiometric Instruments

Refer also to abstracts 32097 and 32341.

32495 (SCTM-232-62(13)) NUCLEAR ALTIMETER. Martin, T. H. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1963. Contract AT(29-1)-789. 14p. Dep. CFSTI.

A prototype nuclear altimeter is described that is capable of measuring air density from 30,000 to 250,000 feet. The unit is self-contained, with the exception of a pressure input line from the station to be measured. It occupies a cylinder 2.5 inches in diameter and 2.75 inches high. One test model was fabricated with favorable results. The power supply, transducer, and detector circuit are described and the test results are given. (auth)

32496 COMPARATIVE EXPERIMENTAL AND THEORETICAL INVESTIGATIONS OF THE DM NEUTRON MOISTURE PROBE. Oelgaard, P. L.; Haahr, V. (Danish Atomic Energy Commission, Roskilde, Denmark). Nucl. Eng. Design, 5: 311-24(May 1967).

Theoretical and experimental investigations of the Danish produced DM subsurface moisture probe are discussed and the results obtained are presented. The DM probe contains an Am–Be fast neutron source and has a glass scintillator containing ^6Li as neutron detector. Through modification of the probe it was possible to vary the source-detector distance in steps. By the use of a three-group diffusion model and a semi-empirical calibration procedure good agreement between measured and calculated curves was obtained. Further, the model was used to study the effect of variations in the dry soil density and in the boron content of soil. Finally the applicability of the model in connection with probe design was considered. (auth)

Miscellaneous Instruments and Components

Refer also to abstract 33123.

32497 (LA–3722) PERSONNEL RADIO-FREQUENCY RADIATION MONITOR. Fey, Frederic L. Jr. (Los Alamos Scientific Lab., N. Mex.). June 9, 1967. Contract W-7405-eng-36. 5p. Dep. CFSTI.

A personnel radio-frequency radiation monitor was developed which indicates exposure to significant rf radiation by an audible chirp. The chirp rate is proportional to the power flux level down to an adjustable threshold which may be set as low as 0.1 mW/cm^2. When this monitor is worn by a person, the threshold could be set at 10 mW/cm^2 to conform with the working level suggested by the American Standards Association. The rf monitor circuit is composed of inexpensive and readily available components contained in a case the size of a cigarette package, yet it is stable and reliable. At a low chirp rate, it can operate continuously for 1 month on a small 4.2-volt mercury battery. This monitor would be valuable in guarding against overexposure and injury of personnel working in facilities where there are high power sources of rf energy, such as radio transmitters, particle accelerators, and radar installations. (auth)

32498 (N–66–38363) PLASMA BEAM CALIBRATION MASS SPECTROMETER. Poschenrieder, Walter P. (GCA Corp., Bedford, Mass.). June 1965. Contract NAS5-9513. 26p. (NASA-CR-68258). CFSTI.

Described is a mass spectrometer which was designed to determine the ratio of atomic to molecular ions in the plasma beam produced by an rf plasma source and a filament plasma gun. Reported are preliminary measurements on hydrogen, nitrogen, and oxygen test gases. (STAR)

32499 (SC-DC–67-1804) IN-PLACE CRYSTAL ACCELEROMETER VOLTAGE CALIBRATION SYSTEM. Tebbs, J. D. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 17p. (CONF-670903-3). Dep. CFSTI.

From 22nd Instrument-Automation Conference and Exhibit, Chicago, Ill.

An in-place crystal accelerometer voltage calibration system is described which is presently being employed to calibrate high impedance voltage amplifiers and magnetic tape recorders used to collect vibration data at Sandia's environmental test facilities. It is basically a master 400Hz power oscillator driving many channels of passive dividers set to simulate the accelerometer voltage. The system is unique in that it compensates for the line load capacitance between accelerometer and amplifier. (B.G.D.)

32500 (SC-R–67-1116) MEASUREMENT OF LONG-DURATION PRESSURE PULSES WITH SHORT PRESSURE BARS. Butler, R. I. (Sandia Corp., Albuquerque, N. Mex.). June 1967. 15p. (CONF-670213-1). Dep. CFSTI.

From 12th Meeting on Interagency Mechanical Operations Group, Subgroup on Environmental Testing, Richland, Wash.

If a pressure pulse is applied to the end of a long, slender, homogeneous bar of constant cross section, the pressure pulse will be transmitted down the bar as a stress pulse that duplicates the pressure pulse in shape, amplitude, and duration. If the bar is instrumented at some station (say by strain gages or the insertion of a thin piezoelectric wafer that matches the acoustical impedance of the bar), the strain-time (or stress-time) output of the instrumented section will describe the pressure input to the bar. Normally the arrival of the reflected pulse from the end of the bar would terminate the useful reading time of the pressure bar. If, however, the medium (usually a gas) in contact with the front of the bar has essentially zero acoustical impedance, and if the instrumented station is very close to the loaded end of the bar, the bar may be used to measure long-duration pulses with extremely short rise times. If the instrumented station consists of a piezoelectric wafer on the end of the bar, then, for a pulse that increases in amplitude linearly with time, the maximum percent error is t/2L, where t is the thickness of the wafer and L is the length of the bar. If the pulse contains an infinite slope (i.e.,

vertical) rise or fall, then the maximum error due to the reflected pulse would be 100%, but the duration of the reflected pulse would be only (X/2L)T, where T is the transit time of the pulse over the length of the bar. The important consideration, then, is to keep t/L small. In gages being built for Sandia Corporation, the ratio of t/L is limited to 0.04. It should be noted that, although many other sources of error are involved in making pressure measurements, only the errors due to reflection of the pressure pulses are discussed here. (auth)

32501 (AEC-tr-6719, pp 113-14) HIGH-RESPONSE TRANSISTORIZED PULSE-HEIGHT DISCRIMINATOR. Fedorov, V. A.; Doroshenko, G. G. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

A transistorized pulse height discriminator with a threshold of nearly 5 mV and a recovery time of 0.1 μsec. is described. (auth)

32502 TRANSISTORIZED 256 CHANNEL ANALYZER WITH MAGNETIC CORE MEMORY. Smiljanic, Gabro (Ruder Boskovic Inst., Zagreb). Nukl. Energ., 4: No. 1, 27-8(1967). (In Slovak).

The properties were described of a transistorized amplitude analyzer. The analyzer has a ferrite core memory of 256 words (channels), 16 beats, and a cycle of around 10 μs. It was designed to operate with an analog-to-digital converter supplying series of pulses for the addressing of channels at a frequency of 20 MHz. The memory can be divided into two groups each of 128 channels. Each group can separately store one complex spectrum. The spectra can be added to each other and also substracted indirectly. Namely, there is a possibility for converting into the negative total of the spectrum recorded in the whole memory, or any half of the memory. The analyzer can provide an analog record of the contents of the memory on a 13 cm cathode ray tube, and can also be connected to a pen recorder. The channels are grouped in 8, and the display of each group on the oscilloscope is illuminated at a different intensity. Digital readout of the contents of the memory is done either by a printer or by a decade counter. The analyzer has the capability of recording the number of pulses in the channels according to a precisely determined time sequence (multiscaling). Farther, it has a device for measuring the total or the real time of the analysis, which can be pre-selected, and for adding a predetermined number into all the channels of the analyzer. The analyzer is controlled by electrical pulses without the use of mechanical switches, which makes possible the automatic operation of the analyzer by the use of an outside programmer. If there is no outside programmer, the pulses can be produced by pressing an appropriate button. These considerations include only the digital portion of the analyzer, i.e. memory, programmer, arithmetical register, oscilloscopic display, printer, etc. Pulse shaping amplifiers, analog to digital converters, high-stability voltage suppliers for the scintillation counters, have not been included in these considerations. (auth)

32503 PROCESSING OF DETECTOR SIGNALS AT VERY HIGH COUNTING RATES FOR PRECISION PULSE-HEIGHT ANALYSIS. Amsel, G.; Bosshard, R.; Zajde, C. (Ecole Normale Superieure, Orsay, France). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 1-48(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

Systems with maximum pulse flow capacity are discussed. It is shown that the upper limit of the permissible counting rates is set by pile up induced phenomena, which are analyzed here. The best pulse stretching mode minimizing pile up is peak value extraction. The basic statistical properties of such a device are investigated. These principles are applied to the design of an electronic system which comprises a fast amplifier, a high speed linear gate and a biased pulse stretcher. The noise properties of the amplifier were studied using the autocorrelation function measured experimentally. The system allows one to detect α particles with satisfactory pile up performances and negligible spectrum distortion in the presence of back-scattered protons up to 10^8 counts/sec. Applications to pulsed high energy accelerators are described. (auth)

32504 OPTIMUM DESIGN OF SENSITIVE TUNNEL DIODE DISCRIMINATORS. Nutt, Ronald (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 110-15(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A new and useful theory was developed to characterize switching properties of the tunnel diode. Expressions for the time delay and time variance for small signals in the presence of amplitude noise were developed for the tunnel diode in the discriminator mode. The expression for time variance is used to determine the parameters of the tunnel diode, and the tunnel diode bias condition to obtain the optimum time resolution for a specified signal and noise. The minimum charge necessary to switch the tunnel diode is calculated for a given signal current pulse width and tunnel diode bias condition. The expressions characterizing the properties of the tunnel diode were developed after the positive resistance region of the device was discovered to be represented very accurately by a sine function in voltage. Since this region of the characteristic curve is responsible for the significant delay and time variance, it is sufficient to describe these properties of the tunnel diode discriminator. The usual equivalent circuit is used to represent the tunnel diode. The second order nonlinear differential equation which is necessary to describe the equivalent circuit is simplified by excluding terms which were insignificant for this particular mode of operation. The simplified differential equation is solved to determine the time for the tunnel diode to switch from its stable bias point to the negative resistance region. This switching time, or delay time, is then used to calculate the time variance. One conclusion resulting from this calculation is that the ratio C/I_p^2 for the tunnel diode must be a minimum to obtain the best time resolution for the case where the significant amplitude noise is generated externally to the tunnel diode. (auth)

32505 TUNNEL DIODE ANALOG TO DIGITAL CONVERTER. Lewyn, L. L. (Space-General Corp., El Monte, Calif.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 126-30 (Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A 10 channel tunnel diode analog-to-digital converter (ADC) was constructed and tested. The converter is a simple stacked discriminator with tunnel diodes used as the quantization elements. The device has a conversion time of less than 10 nanoseconds and a differential linearity on the order of ±3%. (auth)

32506 A GUARDED INSULATED GATE FIELD EFFECT ELECTROMETER. Negro, Vincent C.; Cassidy, Melvin E.; Graveson, Robert T. (Atomic Energy Commission, New York). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 135-42(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

An investigation was made of a new type of insulated gate field effect transistor (IGFET), in which the gate lead is brought through the header in a guarded configuration. Measurements of gate leakage current with the drain connected to the source on this guarded IGFET show that its gate leakage current is less than $1/10$ that of the conventional device, demonstrating that most of the leakage in an IGFET is across the header. When the guarded IGFET is operated in the active region, it is possible to set the operating conditions such that the gate leakage current cannot be measured on the best vibrating reed electrometers. Models of the guarded IGFET which explain the effect of bias on gate leakage current are presented. Others have shown that the IGFET, under proper bias, exhibits a zero temperature coefficient. It is shown how to simultaneously satisfy the bias conditions for minimum gate leakage current and zero temperature coefficient, as well as eliminate drift with time. Biased in this manner, a single guarded IGFET electrometer, which can be battery operated, was built. Its current sensitivity is better than 10^{-17} amperes. (auth)

32507 A NEW APPROACH TO HIGH RESOLUTION TIMING WITH PHOTOMULTIPLIERS. Rota, A.; Bertolini, G.; Cocchi, M. (EURATOM, Ispra, Italy). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 152-7(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A new technique (Double Sampling) of photomultiplier pulse processing is studied in order to improve the time resolution. Two time references, t_1 and t_2, are obtained from two different processing systems, into which the fast pulse of the photomultiplier is fed. If the condition: $(t_1 - t_2) - \Delta t < (t_1 - t_2) < (t_1 - t_2) + \Delta t$ is satisfied, the pulse is accepted for the time analysis. Δt is a predetermined parameter of the proposed system. A theoretical study was carried out in order to compare this processing method with the ones already used. (auth)

32508 A DIGITAL RATEMETER CONTROLLED BY THE INPUT DATA RATE. Tolmie, R. W.; Bristow, Q. (Atomic Energy of Canada Ltd., Ottawa). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 158-61(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

Many radiation counter applications require the rapid response speed of a digital ratemeter, but if large changes in count rate are encountered, a conventional digital ratemeter must be set for a short counting period, producing an excessive number of individual measurements. An instrument is described which avoids this difficulty by automatically adjusting its time base as the count rate changes, the counting period always being such that a preset statistical accuracy is achieved. Further, data readout is inhibited if a

measurement does not differ by a statistically significant amount from the last measurement allowed to transfer to the readout line, or if a sudden increase in rate occurs while a measurement is being taken. For applications in which a single digital ratemeter scans the output lines of a number of detectors, a preset time base limit is provided to prevent time being lost in making measurements of very low count rates or where a counter has failed. Among the display modes is a prediction mode which indicates the rate with increasing accuracy as the count is accumulated. The display utilizes scientific notation, which is very economical of display components and output lines, resulting in an instrument which has fewer parts than a scaler-timer of conventional design. (auth)

32509 RENATRAN BASIC FUNCTIONAL UNITS. Fabre, R.; Gallice, P.; Raoult, N.; Robin, G. (CEN, Saclay, Gif-sur-Yvette, France). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 170-88(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A review is given of the present state of basic functional units developed in France with the assistance of manufacturers to meet the needs of French AEC laboratories. These Renatran plug-in units are in accordance with the Esone standard. Plug-in units' main characteristics and examples of classical experimental settings obtained in assembling various types of plug-in units are mentioned. In the same way, a transcription system towards printers, punching tape devices or computers was studied and a brief description of it is given. (auth)

32510 ADDRESSING OF THE 294 CRYSTAL MOSAIC OF THE DIGITAL AUTOFLUOROSCOPE. DiRocco, James V.; Grenier, Raymond P. (Baird-Atomic, Inc., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 204-10(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A camera-type device, the digital autofluoroscope, recently developed for organ visualization and other applications in the nuclear field is described. The detection head of the autofluoroscope consists of a 6 × 9 inch rectangular array of discrete 1½ inch long NaI(Tl) crystals. The array is made up of 294 crystals forming a grid of 14 × 21 crystals. Each row and column is optically coupled to separate photomultiplier tubes. Pulses that occur simultaneously in any pair of photomultiplier tubes uniquely identify the crystal in which the interaction occurred. Anticoincidence logic is provided to inhibit all pulses arising simultaneously in more than one crystal. The optical coupling between the 294 crystal mosaic and the 35 photomultiplier tubes is accomplished by means of total internal reflection to achieve efficient light conduction in plexiglass light-pipe array. The parameters that govern uniformity and transmission along with the calibration of the instrument are discussed. (auth)

32511 USE OF DIGITAL TECHNIQUES FOR NUCLEAR INSTRUMENTATION. Fuan, J.; Furet, J.; Kaiser, J. (CEN, Saclay, Gif-sur-Yvette, France). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 233-40(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The possibilities of increasing the use of digital techniques in reactor control instrumentation lead to several studies which are described. They concern chiefly prototypes of linear ratemeters and digital periodmeters with a method for automatic change of response time. The measurement of neutron flux with good accuracy over a ten-decade range with one or two detectors is discussed. The use of digital techniques even for the measurement of dc current given by neutron detectors is also analyzed. (auth)

32512 IN-CORE INSTRUMENTATION AND FAST DIGITAL DATA ACQUISITION FOR THE SEFOR NUCLEAR TEST REACTOR. Glauner, H. W. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.); Pflasterer, G. R.; Momberger, J. F. IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 293-9 (Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The primary purpose of the SEFOR nuclear test reactor is to measure the dynamic behavior of a fast reactor core. Special in-core instrumentation was developed for fuel and sodium temperature and sodium flow rate measurements. Neutron detectors were built and tested which will measure reactor power peaks up to 10^6 MW. A fast computer-controlled data acquisition system allows sampling rates up to 30,000 data/sec. The system provides for minor data reduction and analysis. (auth)

32513 PULSE ASSEMBLY FOR REACTOR CONTROL. Buisson, J.; Garau, J. (CEN, Saclay, Gif-sur-Yvette, France). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 307-20(Feb. 1967). (In French).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

This assembly is connected to pulse neutron detectors: fission chamber, BF_3 counter, boron counter. No preamplifier is needed. The input impedance of the amplifier is matched to the impedance of the coaxial cable connected to the detector. The assembly can work with a length of cable between the detector and the electronics as long as 200 meters. The effects of reducing the electrical interferences on the cable and on the assembly have been studied and the results of the tests done near different reactors are given. The current collection mode is used. The useful range of the assembly is limited by the collection time of the detectors and it allows a maximum range of 5.10^6 c/s with an accuracy of 10%, taking into account statistical fluctuations. The description of the electronic circuits of the assembly is given: amplifier, dc level restoring circuit, discriminator. It is possible to use the two outputs of the assembly in digital mode (calibrated pulses) and in analog mode (dc current proportional to the counts per second: 10^{-11} A/C) and so a digital or an analog rate meter can be used. The assembly is built with 6 modular blocks: transformer, low voltage dc supply, high voltage supply, pulse amplifier, discriminator and tests. (auth)

32514 NEW DEVELOPMENTS IN LOGARITHMIC AMPLIFIERS. Gilmour, G. A. (Astronuclear Lab., Pittsburgh). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 321-4 (Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A series of logarithmic amplifier designs based on follower type circuits is described. One circuit contains only three components and covers the range 10^{-10} to 10^{-3} amp. Another circuit contains four components and covers the range 10^{-7} to 1 amp for pulsed operation. A circuit which has been radiation hardened and temperature compensated for pulses in the range 10^{-5} to 1 amp is shown. (auth)

32515 MULTIPURPOSE CURRENT AMPLIFIER FOR NUCLEAR REACTOR POWER MEASUREMENTS. Watson, L. D. (Phillips Petroleum Co., Idaho Falls, Idaho). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 325-7(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The SPERT reactors at the National Reactor Testing Station near Idaho Falls, Idaho, are routinely subjected to rapid power excursions to investigate their inherent safety characteristics. During these rapid excursions, the power varies from 10^{-2} to 10^{10} watts within milliseconds. Current amplifiers used in conjunction with ion and rad chambers to monitor this power change require a bandwidth of 20 kHz with a signal to noise ratio of 40 db or better at current levels of 10^{-6} amperes and higher. This measurement is further complicated by electrical fields from plant operation as well as gamma fields with strengths of up to 1000 R/hr at the amplifier location. A current amplifier put into use at the SPERT facilities, and which lends itself to reactor pulse applications, is a modified version of a commercially available solid state charge amplifier. The modification consists of replacing the capacitive feedback network in the charge amplifier with a resistive network. The modified amplifier has a bandwidth of 35 Hz at 10^{-9} amperes, 350 Hz at 10^{-8} amperes, 3.5 kHz at 10^{-7} amperes, and 20 kHz at 10^{-6} or greater amperes. These bandwidths will hold with up to 100 feet of RG-58 cable on the input. The amplifier has signal to noise ratios of 34 db, 40 db, 46 db on the corresponding current ranges of 10^{-9}, 10^{-8}, 10^{-7} amperes. For current ranges of 10^{-6} amperes and higher, the signal to noise ratio is that inherent to the amplifier, 52 db. Special mounting and housing techniques are used to reduce pickup of stray noise. A three level grounding and shielding technique (rack, chassis, and circuit) has reduced all external 60 Hz source effects to a level below the intrinsic noise of the amplifier. This modified charge amplifier has worked very well for SPERT's application for a current amplifier. The applications include use as an 8 decade log amplifier, remote controlled operational current linear amplifier with ranges of 10^{-11} to 10^{-2} amperes and as a pulse current linear amplifier with ranges of 10^{-9} to 10^{-2} amperes. (auth)

32516 TRANSISTORIZED FAIL-SAFE TRIP AMPLIFIER. Ahmed, Muhammad I. (20th Century Electronics Ltd., Surrey, Eng.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 328-32(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A novel transistorized fail-safe trip amplifier to use in the control of a nuclear reactor is described. The trip unit is inherently

safe by virtue of the trip point being independent of the amplifier gain, since its output is zero, when the signal exceeds or equals the trip setting. The trip setting may be changed over the range of 0 to 5 volts, the unit can be used as a low or high level and high-low trip. The amplifier has a dynamic input current range 10^{-3} to 10^{-6} and the drift of the unit is less than 10^{-9} A for long term and temperature variation, accuracy, and stability better than ±0.1%. (auth)

32517 THE MATERIALS SELECTION PROBLEM AS RELATED TO THERMOCOUPLES USED TO MEASURE NUCLEAR REACTOR FUEL PIN TEMPERATURES UP TO 2800°C. Popper, G. F.; Knox, A. E. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 333-41(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The materials that might be useful for constructing high temperature fuel pin thermocouples are reviewed. The materials selection problem is confined to three areas—i.e., sheath, electrical insulator, and thermoelement materials—with the major emphasis placed on the selection of electrical insulators. The determination of insulator properties and their effect on thermocouple performance are considered. Potential modes of thermocouple failure are illustrated, and a prototype thermocouple is described. (auth)

32518 THE DESIGN AND PERFORMANCE OF A 1200°F MAGNETIC FLOWMETER FOR IN-CORE APPLICATION IN SODIUM-COOLED REACTORS. Popper, G. F.; Glass, M. C. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 342-7(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A magnetic flowmeter that may be used in the core of a 1200°F sodium-cooled reactor was designed and partially tested. The flowmeter is constructed in the shape of a hexagon so that it can be completely self-contained as a part of a reactor fuel element. An integral stainless steel sheath, alumina insulated, stainless steel lead wire is provided for signal transmission. Complete construction and design details are presented. The effects of temperature and nuclear radiation on the magnet stability are considered and discussed. The preliminary test results are given and compared to the calculated performance. (auth)

32519 THE DEVELOPMENT OF AN ACOUSTICAL THERMOMETER FOR A GRAPHITE MATRIX NUCLEAR FUEL ELEMENT. Roes, J. B.; Peat, D. L. (General Atomic Div., San Diego, Calif.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 348-59(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The development of an acoustic thermometer for use in graphite matrix nuclear fuel elements is described. Test results indicate that this thermometer accomplished the objective of automatically, accurately, and reliably recording temperatures of a number of sensors. The acoustic thermometer system offers a wider choice of signal transmission line and sensor materials than conventional thermometer systems, since it does not require the use of electrical insulators or the conductors in them. This advantage was the main reason for choosing the acoustic thermometer for use in the particular environment of interest. While the development of the thermometer was directly aimed at the solution of problems associated with a nuclear and carbonaceous environment, a number of observations are presented that should be pertinent to acoustic thermometer design in general. (auth)

32520 PROTOTYPE INSTRUMENT FOR CONTROLLING REACTOR STARTUPS. Philipp, L. D.; Bunch, W. L.; Wood, M. R. (Battelle-Northwest, Richland, Wash.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 228-32(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A time-to-power instrument was developed for use as a primary startup control for nuclear reactors. Time-to-power (TTP) is the projected length of time that will elapse before reactor goal power is reached, as based on the instantaneous neutron flux level and the reactor periods. Thus, the TTP signal is formed by combining the logarithm and period of the neutron flux level (both normally-used startup control signals), with an internally-generated goal flux level signal. The resultant TTP signal is displayed for comparison with the desired TTP value. Maintaining a constant desired TTP signal by adjustment of reactivity controls results in an orderly approach to a selected goal power level. The design considerations of the prototype system are presented with a discussion of the present and future applications. The developed, practical instrument satisfactorily performed the electronic functions required to demonstrate the TTP concept, and data from controlled reactor startups compare favorably with the calculated behavior. The results indicate that safe, efficient and economical startups can be obtained using TTP instrumentation. (auth)

32521 IMPROVED NEUTRON IMAGE INTENSIFIER TUBE. Berger, Harold (Argonne National Lab., Ill.); Dolon, Paul; Niklas, Wilfrid F. IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 428-32(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The light yield of an improved neutron image intensifier tube is discussed and compared with other tubes developed previously. The major portion of the improvement in light yield is attributed to the use of ZnS(Ag) phosphor in the neutron scintillator of the tube rather than ZnCdS(Ag) used previously. (B.G.D.)

32522 PHOTOMULTIPLIER SINGLE-ELECTRON TIME-SPREAD MEASUREMENTS. Kerns, Cordon R. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 449-54(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A large variety of nanosecond-response, high-gain phototubes for use in high-energy particle detectors is available to users. The time spread, gain, and noise properties of such tubes are important to know for selection of a suitable type. The 24 to 30% quantum efficiency of phototubes containing bialkali photocathodes for instance, along with their low noise offered at gains up to 3×10^7, make them especially desirable in Cherenkov counters. Measurements are presented of single-electron time spread for several 8575's, 56AVP's, 6810's, C70133's, 2067's and 7264's. Using the measuring equipment, voltage ratios in the focus-electrode system for optimum collection and minimum time spread were found. A description of the measuring system is included. Two alternative ways of expressing the time spread are given. All tubes were magnetically degaussed and were shielded for these measurements. (auth)

32523 EXTRANEOUS LIGHT EMISSION FROM PHOTOMULTIPLIERS. Krall, H. R. (Radio Corp. of America, Lancaster, Pa.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 455-9(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

Various extraneous light-emission phenomena are described that limit the application of the photomultiplier, or photomultipliers in coincidence, to the detection of light levels higher than that limit set by thermionic emission from the photocathode or photocathodes. Four sources of extraneous light within the photomultiplier are discussed: electrode glow; dielectric glow, which includes electro-luminescence and phosphorescence; Cherenkov radiation and faceplate scintillations; and residual gases within the volume of the photomultiplier. Data are given on the timing, the pulse-height distribution, and the efficiency of various light-emission processes. A brief summary is given on the recent progress made toward the reduction of extrinsic noise activity encountered in photomultipliers operated at light levels in the order of a few quanta per second. (auth)

32524 ON-LINE COMPUTERS: A SURVEY OF TECHNIQUES AND CONCEPTS APPLIED TO LOW-ENERGY NUCLEAR RESEARCH. Jones, J. A. (Digital Equipment Corp., Maynard, Mass.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 576-90(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The general-purpose stored-program computer has become more and more prevalent as the central on-line element in today's facilities for low-energy nuclear research. The techniques for on-line data taking and the benefits to be derived from the computer usage were explored. The operating concepts of early and present installations are surveyed and related to the computer hardware and software that have been selected. A look is taken at some proposed installations for the future and the issues they raise. (auth)

32525 USE OF TRANSFORMATIONS IN MULTIPARAMETER DATA SORTING. Whitehead, A. B.; Parker, R. H.; Haines, E. L. (California Inst. of Tech., Pasadena). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 599-603(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

A major problem in multiparameter data sorting is the excessive computer memory space required for all of the available information. A sorting technique is described which is useful if the information in one parameter can be represented by a simple distribution which can be described by the coefficients of an appro-

priate transformation. It is possible to compute the coefficients without accumulating the data in spectral form. For example, consider a three parameter experiment where the events are characterized by x, y, and f(x,y). Suppose that the purpose of the experiment is to map the amplitude, mean, standard deviation, skew and kurtosis of f(x,y) over the x-y plane. It is necessary to reserve only five words in the computer memory for each location in the x-y plane. During the sorting process, the quantities accumulated in these five registers are Σa_i^1, Σa_i^2, Σa_i^3, Σa_i^4, Σa_i^4 where a_i is the digital value of f(x,y) for the i^{th} event. Use of the Gauss-Hermite quadrature and the Fourier transformation is discussed and illustrated by an example (the measurement of secondary electron yields as a function of fission fragment mass and energy). (auth)

32526 AN INVESTIGATION OF HIGH ENERGY ELECTRON PRODUCED SHOWERS USING A COMPUTER-CONTROLLED SYSTEM. Yearian, M. R. (Stanford Univ., Calif.); Crannell, C. J.; Crannell, Hall; Smith, Daniel C.; Friedl, P. J.; Sederholm, C.; Dye, W. IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 608-10(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19-21, 1966. See CONF-661020.

A description of a computer-operated system for studying the development of electromagnetic showers initiated by high-energy electrons in various materials is presented. Sample results are shown for a shower produced by a beam of 900-MeV electrons incident on a block of copper. The research program in which the system will be utilized is briefly described. (auth)

32527 SPACE SCIENCES DATA PROCESSING. Ludwig, George H. (Goddard Space Flight Center, Greenbelt, Md.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 626-33(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19-21, 1966. See CONF-661020.

Spacecraft carrying large numbers of scientific instruments are presently transmitting data at the rate of approximately 100 million data points per day. The outputs of the sensors are partially processed on the spacecraft and transmitted to the ground. These data must then be converted from raw digital form into a conceptually meaningful form which the experimenters can analyze and from which they can draw valid conclusions about the phenomena being measured. At present the ground processing is done in several steps. The first includes conversion of the raw data acquisition station tapes into computer tapes and includes signal clean-up, establishment of synchronization, and time decoding. In the newest processing lines this first step also includes a moderate amount of editing and quality control. The rest of the steps involve large scale computers and include further editing, establishment of accurate timing, computation of the spacecraft attitude, and sorting, to provide data tapes for the individual experimenters. The experimenters have the responsibility for the further reduction to more meaningful form. These operations include further sorting, storage, compilation, computation, and display. There is at present a great need for additional development of analysis and display programs, techniques, and equipment to assist in this work. (auth)

32528 AUTOMATIC ENERGY SCANNING BY TARGET SELF CHARGING FOR HIGH PRECISION MEASUREMENTS OF RAPIDLY VARYING CROSS SECTIONS. Amsel, G.; d'Artemare, E. (Ecole Normale Superieure, Paris). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 189-203(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19-21, 1966. See CONF-661020.

An instrument was developed to trace excitation curves of nuclear reactions induced by charged particles at low energies with a precision of the order of 50 eV. Energy scanning periods of the order of one second were achieved, with total variations ranging typically from 2 to 20 keV. Good linearity was obtained with beam currents down to about 10^{-8} A. Applications to the measurements of the cross section of the reaction $^{18}O(p,\alpha)^{15}N$ near the narrow resonances at 628 and 1766 keV at two angles simultaneously are described. Results are presented on the energy straggling of protons through 150 Å thick foils, showing the asymmetry effects predicted by theory, using the narrow resonance at 1165 keV in the same reaction. The basic idea consists of controlling the scanning speed by the beam current itself, using target self charging. The fluctuations of the current do not therefore, by definition, impair scanning uniformity. The device is thus especially convenient for Van de Graaff type accelerators. An extension of the method for scanning parameters other than energy is described. An example is given, showing high precision automatic angle scanning in channeling experiments, where electrostatic deflection of the beam is used. Steps of 3 minutes of arc were achieved without any moving part in the system. (auth)

32529 MODULAR ELECTRONIC INSTRUMENTATION FOR REACTOR CONTROL. Buisson, J.; Furet, J.; Plaige, Y.; Quenee, R.; Weill, J. (CEN, Saclay, Gif-sur-Yvette, France). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 300-6(Feb. 1967). (In French).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19-21, 1966. See CONF-661020.

The purposes of actual studies concerning reactor control instrumentation connected with neutron detectors are essentially: the possibility to put far away electronic devices from the neutron detectors, eventually to cancel preamplifiers (so that the electronic devices will operate in normal conditions without damage due to radiations and temperature); the increase of the scale and the discrimination ratio between neutrons and gamma measurements, chiefly for pulse amplifiers; and a better compromise between time constant and noise for all the levels of electric information given by the neutron detectors. The results of these studies are given and also the description of the different modular blocs is done; main characteristics are mentioned: scale, accuracy, time constant, etc... The various possibilities for connection between the different blocs show that modular electronics for reactor control instrumentation is well fitted with the increase of automatic devices and the concentration of measurements in reactor control. A great number of tests of this new instrumentation have been done on several experimental reactors and the results are given (including the rate of failures). (auth)

32530 GENERATIONS ONE AND TWO: NUCLEAR PHYSICS EXPERIENCE WITH ON-LINE COMPUTERS. Mollenauer, James F. (Bell Telephone Labs., Inc., Murray Hill, N. J.); Rogers, P. C. IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 611-13(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19-21, 1966. See CONF-661020.

The installation of an SDS 910 computer at the Brookhaven 60 in. Cyclotron four years ago represented one of the first on-line computer applications in nuclear physics. The experience gained with this computer and its application to the design of a second-generation system indicates some of the problems inherent in a computer-oriented laboratory as well as possible solutions. The development of a new system has been undertaken jointly at the Rutgers/Bell Accelerator at which the 910 system is now located and at the Brookhaven Cyclotron, in view of the common data handling problems at the two laboratories. In its present location the 910 is used 90% of the time by staff and students for data collection, leaving very little time for data analysis and programming. Experience indicates that these activities each require at least as much time as data collection in order to use the accelerator to best advantage. The solution to this problem is to use an advanced time-sharing computer to handle all applications from a number of user consoles. By using a fast disc file both to store data being accumulated and to furnish display information directly to the oscilloscopes, the central processor will be freed most of the time for program compiling and computation. Program development will be greatly speeded by the storage of source programs on the disc, with conversational editing and debugging from the consoles. The new system will have push button initiated routines to handle the most common data collection and analysis operations; it should be possible to eliminate a major part of the programming burden to the setting up of experiments by the use of standard routines. (auth)

32531 SOME ASPECTS ON AN ANGLE MEASURING INTERFEROMETER USING CUBE CORNER PRISMS. Rohlin, J. (Chalmers Tekniska Hogskola, Goteborg). Ark. Fys., 33: 25-36(1967).

The principles of an interferometer system for precision angle measurements have been previously described. The interferometer is of the Michelson type with plane end mirrors and designed with cube corner prisms to follow the rotation. The system is discussed with the main emphasis layed on an analysis of the properties of the interference fringe pattern. Under very general conditions the optical path difference is derived to a third degree approximation. The effect of the cube corner prisms is shown to be equivalent to that of twice traversed parallel plates. The conditions for photoelectric fringe detection are discussed. (auth)

32532 MAGNETIC SPECTROGRAPHS. Enge, Harald A. Phys. Today, 20: No. 7, 65-71; 73; 75(July 1967).

The operating principles and applications of magnetic spectrographs are given. Several different designs and spectrographic trends are discussed. (B.G.D.)

32533 DIGITAL RECORDING MARINE BAROMETER. Kodama, Masahiro; Gotoh, Eiichiro; Nakatani, Hideo. Sci. Pap. Inst. Phys. Chem. Res. (Tokyo), 61: 1-6(Mar. 1967).

A new type of marine barometer provided with a digital recording system was developed mainly for the purpose of cosmic ray measurements aboard. It is shown that this barometer is scarcely

affected by the phenomena such as surge, pitching and rolling within ±40°, gravitational acceleration, and high winds of less than 40 m/sec. Under these conditions, an accuracy of ±0.4 mb or better in the barometric readings is achieved. (auth)

32534 NONSTEADY COAXIAL ARCS IN FULLY DEVELOPED PLASMA FLOW. Prelewicz, D. A.; Benenson, D. M. (State Univ. of New York, Buffalo). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 1320-4(July 1967).

A simplified analytical model representing arc operations under conditions of nonsteady electrical inputs is considered. The assumptions that Emmons applied to the steady-state case are imposed: discontinuous model for electrical conductivity, other gas properties constant, fully developed flow within a tube. Solution of the energy equation (uncoupled from the momentum equation) is obtained separately in each of two regions: the heated zone (wherein electrical conductivity differs from zero) and the unheated zone. The solutions are joined at the arc boundary (critical radius), resulting in a moving boundary problem. Using the Green's function method, an integral equation for the boundary motion and integral equations for the temperature profiles in the two regions are obtained. Approximate solutions of these equations are obtained for small times. The case of a step function pulse of the source was considered; numerical solutions of the integral equations were obtained over the complete time range. Solutions obtained according to the approximate method are in good agreement with the numerical calculations. Arc extinction was also studied using a negative pulse of sufficient strength. (auth)

32535 HIGH-VOLTAGE STABILIZED POWER SUPPLY FOR PHOTOMULTIPLIERS. Caroussos, P. (Institut d'Optique, Paris). Rev. Phys. Appl., Suppl. J. Phys., 1: 300-2(Dec. 1966). (In French).

A high voltage power supply, especially suited for photomultipliers, is described. The three principal units are described in detail: a low voltage supply with electronic protection, a high voltage converter and a regulator. The maximum current is 2 mA and the regulation is 3×10^{-4} for the maximum output voltage. (auth)

32536 MULTIPARAMETRIC RECORDING DEVICE WITH 82 BINARY DIGITS. Kamoun, R.; Ballini, R. (CEN, Saclay, France). Rev. Phys. Appl., Suppl. J. Phys., 1: 293-7(Dec. 1966). (In French).

The design of a multiparameter recording device for alpha particles and gamma radiation is shown, and the order for the synchronization of the various operations is given. The device is made of standard elements. A buffer memory allows it to be used over a long period of time when recording at a low counting rate. (J.F.P.)

32537 A METHOD FOR TESTING THE LINEARITY OF A PHOTOMULTIPLIER. Bressani, T.; Brovetto, P.; Rucci, A. (Univ., Cagliari, Italy). Nucl. Instrum. Methods, 53: 41-4 (July 1967).

A method, using the phase sensitive detection technique, for checking the linearity in the behavior of a photomultiplier is described. Some experimental results are reported to show how the method can be applied. (auth)

32538 LINEAR VARIABLE-GAIN PULSE AMPLIFIER FOR STABILIZING SYSTEMS. Remigolsky, B.; Tepper, L. (Israel Atomic Energy Commission, Yavne). Nucl. Instrum. Methods, 53: 29-34(July 1967).

A linear variable-gain amplifier is described and the main design problems are analyzed. Two important variations from more conventional configurations are introduced. The one concerns the position of the variable element, which, it is shown, must be outside the feedback loop if a constant rise time is to be achieved. The other is the use of local feedback for the FET (used as a variable resistance) in order to achieve high linearity. A discussion is given of the inherent linearity of planar and cylindrical FET's, as well as of the same FET's with local feedback. Practical results and a complete schematic are given. (auth)

32539 USE OF A 4096-CHANNEL ANALYZER FOR THE REGISTRATION OF ANGULAR DISTRIBUTIONS BY SIMULTANEOUS DETECTION AT 20 ANGLES. Gorodetzky, S.; Graff, J.; Thirion, J. M.; Chouraqui, G.; Vautrin, J. P.; Port, M. (Institut de Recherches Nucleaires, Strasbourg). Nucl. Instrum. Methods, 53: 22-4(July 1967). (In French).

A device is described which stores the energy spectra delivered by 20 counters simultaneously in a 4096 channel-pulse-height analyzer. The method is based on the mixing of the proportional pulses of all counters and on the production of the corresponding digital pulses coding the pulse origin. The circuits needed for realization are described. This device was used to study angular distributions of the $^{18}O(p,\alpha)^{15}N$ reaction. The extension to 32 counters is possible. (auth)

32540 A COMPUTER-BASED MULTIPARAMETER RECORDING SYSTEM FOR NEUTRON RESONANCE CAPTURE GAMMA-RAYS. Bhat, M. R.; Borrill, B. R.; Chrien, R. E.; Rankowitz, S.; Soucek, B.; Wasson, O. A. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods, 53: 108-22(July 1967). (BNL-11212).

Data acquisition for the HFBR chopper is accomplished by using a computer-controlled multiparameter magnetic tape recording system. The neutron time-of-flight and corresponding pulse height of the γ ray following neutron capture are encoded, stored on tape, and sorted to produce representative spectra for monitoring the experiment. Sorting and analysis of the resulting tapes is carried out in detail at a central computing facility. Such features as automatic gain monitoring, and the time-sharing of the computer between data collection and programming are described. (auth)

32541 A NEW TIME ANALYZER. Yousefkhani, A. (Tata Inst. of Fundamental Research, Bombay). Nucl. Instrum. Methods, 53: 91-2(July 1967).

A multichannel time analyzer was described which makes use of a novel switching scheme. This scheme, which consists of a pair of fast switching scalers, allows use of slower circuitry in the rest of the system. Details of the logical design of this system are given. (auth)

32542 NANOSECOND PULSE STRETCHER. Goyot, M.; Pigneret, J.; Remillieux, J.; Samueli, J.-J.; Sarazin, A. (Univ., Lyon). Nucl. Instrum. Methods, 53: 87-90(July 1967).

A circuit which performs the stretching of nanosecond pulses between 0.5 and 10 V is described. Peak amplitude information is preserved and the output length is acceptable to a pulse-height analyzer. Typical nonlinearity is 2% and the temperature coefficient is 5×10^{-4}/°C. A medium-speed version designed to handle pulses with rise time larger than 10 nsec has a nonlinearity of 0.5% and a temperature coefficient of 1.5×10^{-4}/°C. (auth)

32543 COMPUTER METHOD FOR DEDUCING NUCLEAR LEVELS FROM MEASURED TRANSITION ENERGIES. Baecklin, A. (Univ. of Uppsala. Swedish Research Councils Lab., Studsvik). Nucl. Instrum. Methods, 53: 177-9(July 1967).

On the basis of numerical relationships between a set of measured transition energies and a set of known level energies a computer calculates energies of possible new levels and the probabilities of these levels being accidental. (auth)

32544 FAST PULSE AMPLITUDE DISCRIMINATOR WITH A SHAPING CIRCUIT. van Zurk, R. (CEN, Grenoble, France). Nucl. Instrum. Methods, 53: 45-55(July 1967). (In French).

A fast pulse amplitude discriminator for general use, with a shaping circuit having zero recovery time, is described. Its principal features are: continuously adjustable threshold (50 to 500 mV), minimal resolving time (10 ns), two fixed values of scaler output width, two outputs with adjustable widths (by means of a clipping line), coincidence-anticoincidence gate, test facility, multiple triggering free, and overload protection. (auth)

32545 THE PROPERTIES OF THE SINGLE-CHANNEL ANALYZER VA-W-02. Hennig, D. (VEB Vakutronik, Dresden). Kernenergie, 10: 107-11(Apr. 1967). (In German).

The rapid development of nucleonics, especially of gamma-ray spectrometry, involved higher requirements of the users, which VEB Vakutronik WIB Dresden has been met by the construction of some new measuring instruments, among them the single-channel analyzer VA-W-02 available both as an independent device and as the subchassis of the single-channel spectrometer VA-M-120. As compared to its predecessor VA-W-01 the new analyzer distinguishes by its improved comfort of operation, higher resolving power, more stable and exactly reproducible channel widths, and the possibility to be used in coincidence measurements. (auth)

32546 PUNCH-CONTROL AND READOUT SCANNER /Q-2752/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1603).

11 drawings.

A punch-control and readout scanner used to transfer data from the arithmetic unit of the ND-160 4096 channel pulse height analyzer is described. The punch-control and readout scanner has perforated paper tape and Nixie numerical indicator tubes for reading out analyzer-channel count information. Information from 4096 channels can be recorded on paper tape in 2 min. An interface unit is included to connect the ND-160 M, 4096 channel arithmetic units to the computer. A multiposition switch routes data lines to either the paper tape punch control or the data center (see CAPE-1605). Two minutes are required to dump the 4096 channels. (For details see TID-4100 Suppl. 41). (F.S.)

32547 ANELASTICITY SYSTEM CONNECTOR UNIT /Q-2897/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1594).

1 drawing.

The closed-loop anelasticity system is described which consists of six amplifiers with individual gains of 6, 1 to 32, 1 to 10, 1 to 6, and 1. The system senses the oscillation of a sample and automatically adjust its gain to maintain its input level (sample amplitude) constant in spite of changes in sample decrement and other disturbances in the measurement of sample strain and decrement in the dynamic range of the amplifier. The dynamic range can be expanded by adjusting either or both gain and attention. The system provides precise phase shifts of +45 or −45° of the frequency of oscillation (~20 kilohertz), which will force the sample to operate at its half-power points both above and below its resonant frequency. Frequency difference between these two points will permit calculation of the sample decrement. (For details see TID-4100 Suppl. 40). (F.S.)

32548 BETA-EXCITED LIGHT SOURCE PHOTOMETER /Q-2901/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1499).

15 drawings.

A β-excited light source photometer is described which was designed for measuring light absorption of liquid samples. The light source consists of a liquid scintillation material mixed with a β-emitting radioisotope in a standard absorption cell. Visible light is emitted as pulses from the source. The intensity of the pulses is not constant. The electronic equipment is commercially available except for the preamplifier circuit which is included in the package. For details see TID-4100 (Supp 40) (F.S.)

32549 FARADAY CUP AND QUANTAMETER (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE–1587).

11 drawings.

A high precision 20-GeV Faraday cup and a quantameter are described. The Faraday cup has unity efficiency for electrons or positrons to an accuracy of better than ±0.1% at energies up to 20 GeV. The quantameter has a gain linear in electron, positron, or photon energy to ±0.1%. In tests with the Faraday cup using an electron beam, the quantameter was calculated to ±0.3% and its linearity established to an accuracy of ±0.2% at energies up to 15 GeV. (For details see TID-4100 Suppl. 40) (F.S.)

32550 MERCURY RELAY PULSE GENERATOR-MARK II /Q-3037/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1589).

1 drawing.

A highly stable, linear pulse generator is described which is used in evaluating multichannel analyzers having as many as 4000 channels. The generator uses a mercury-wetted relay as the basic pulse-forming device. The relay charges a capacitor from a highly stable, continuously variable dc reference supply and discharges the capacitor through a 50-Ω resistor in series with the 50-Ω load. A frequency from 1.2 to 60 cps can be selected in seven steps. The continuous variable dc reference was obtained from the wiper of a 100-Ω Fluke precision decade potentiometer supplied by a 10V regulated source. The pulser supplies essentially a 0- to 5-V pulse into a 50-Ω load with a decay time constant of 500 μsec and a rise time of 1 to 3 nsec. (For details see TID-4100 Suppl. 40.) (F.S.)

32551 SLIDING PULSE GENERATOR /Q-3030/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1588).

1 drawing.

A sliding pulse generator is described which is used in checking the linearity of 4000-channel multichannel analyzers in the field. The instrument is packaged in the standard NIM module. The amplitude of the output pulses, which occur at a rate of 250 per sec, varies directly with a generated, continuous running ramp having a slope of 66.7 mV/sec. The nonlinearity of this ramp is less than 1 part in 10^4. Output amplitude can be varied, by a selector knob on the front panel, between any two voltage levels from 0 to ±10V. The ramp slope is monitored on a chart recorder for long-term runs by means of a differentiating circuit. The instrument consists of a ramp generator, ramp control circuitry, ramp slope monitor, and mercury relay chopper. When connected to a 10 mW strip recorder, the differentiator will indicate nonlinearities as small as 5 parts in 10^5. The temperature coefficient of the differentiator circuit is ~12ppM/°C negative; the temperature coefficient of the differentiator circuit offset potentiometers is ~70 ppM/°C, increasing a magnitude as the ambient temperature increases. (For details see TID-4100 Suppl. 14.) (F.S.)

32552 DOUBLE BEAM PHOTOMETER /Q-2909/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1590)

2 drawings.

A double-beam differential null-balancing photometer is described for use in examining zirconium weld test specimens. A photomultiplier tube monitors the incoming monochromatic beam from a Zr arc lamp, and a second photomultiplier tube monitors the reflected light from the test specimen mounted on the microscope stage. The signal from the second photomultiplier tube is amplified and applied to the normal (y) axis of an x–y recorder. The normal reference voltage for the x–y recorder pen axis servo-positioning loop is replaced by the amplifier phototube voltage derived from the incoming monochromatic beam allowing a cancellation of the fluctuations caused by the instability of the Zr arc lamp. The carriage (x) axis input of the x–y recorder is supplied from an angular position sensor attached to the rotary mechanical stage of the microscope. (For details see TID-4100 Suppl. 40.) (F.S.)

32553 HERBAGE METER /Q-2838/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1593).

1 drawing.

An instrument is described which measures the mass of plant fibers and the water contained by the fibers without disturbing the plant growth. The measurements are made quickly to avoid excessive exposure to radiation in fields that have been contaminated with radioactive isotopes. The instrument consists of a capacitance probe made up of 36 insulated rods mounted on a Fiberglass board, and a heterodyne frequency meter that will measure small changes in capacitance. The probe covers 450 $in.^2$ of ground and will accommodate plants 36 in. high. The meter is stable, showing zero drift over several hours operation or large temperature changes. A 14 or 15 V mercury battery having 1A/hr rating powers the instrument for a growing season. (For details see TID-4100 Suppl. 40.) (F.S.)

32554 STUDY OF THE INHOMOGENEOUSLY SHEATHED SPHERICAL DIPOLE ANTENNA IN A COMPRESSIBLE PLASMA. Larson, Ronal Worthington. Ann Arbor, Mich., Univ. of Michigan, 1966. 216p.

Thesis.

The radiation properties of a spherical dipole in a compressible plasma were investigated. Because an electron sheath forms around a perturbing body in a plasma, this analysis considers the effects of plasma inhomogeneities, and static electric fields on the terminating admittance of the dipole, and the spatial variations of the fields. (TSS) (Disser. Abstr.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 32944.

32555 EFFECTS OF IONIZING RADIATION ON OXIDIZED SILICON SURFACES AND PLANAR DEVICES. Snow, E. H.; Grove, A. S.; Fitzgerald, D. J. (Fairchild Semiconductor Corp., Palo Alto, Calif.). Proc. IEEE (Inst. Elec. Electron. Eng.), 55: 1168-85(July 1967).

The effects of high and low energy electron, x-ray, and ultraviolet radiation on oxidized silicon surfaces and planar devices are investigated. Two permanent effects of ionizing radiation on oxidized silicon surfaces are distinguished: (1) The buildup of a positive space charge within the oxide, and (2) The creation of fast surface states at the oxide-silicon interface resulting in increased surface recombination velocity. The dependence of these effects on dose and dose rate, on bias applied during irradiation, and on structural parameters is discussed and a theory is presented which accounts for the observed features of the space-charge buildup. This theory involves trapping of holes which are generated within the oxide by the radiation. It is shown that all details of the experimental observations can be accounted for by assuming a high density of the hole traps near the oxide-silicon interface which decays rapidly with distance into the oxide. Radiation-induced changes in the characteristics of MOS and junction field-effect transistors, p-n junction diodes, and p-n-p and n-p-n transistors are reported and examined in terms of the above two effects. It is shown that the charge buildup causes shifts in the operating point of MOS transistors, catastrophic increases in the reverse current of p-n junctions, and variations in their breakdown voltage. The increase in fast surface-state density is responsible for the lowering of the transconductance of MOS transistors and, in combination with the space-charge buildup, for the degradation of the current gain in bipolar transistors. It is shown that junction field-effect transistors are relatively insensitive to both effects of ionizing radiation and therefore offer the most promise for use in ionizing radiation environments. (auth)

32556 ON THE BEHAVIOR OF SELENIUM PHOTOVOLTAIC CELLS DURING AND AFTER IRRADIATION WITH ^{60}Co-γ-RADIATION. Storbeck, Ingrid (Inst. of Metal Physics and Purest Metals, Dresden). Jena Rev., No. 4, 237-40(1966).

Dynamic characteristics were recorded before and after ^{60}Co-γ-irradiation. Measurements were made on the dependence of the photocurrent and photovoltage on light before and after irradiation. Results indicated that high radiation doses, just as high light intensities, cause an aging of selenium photovoltaic cells. If load resistances are not excessively low, however, the photocurrents are only slightly changed even after irradiation with relatively high doses. Photocurrents were also measured during irradiation. (J.G.B.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 32414, 32635, 32637, 32697, and 32766.

32557 (CEA-R-3064) CONTRIBUTION A L'ETUDE PHARMACOLOGIQUE DU TRANSPORT DES COLLOIDES D'OR RADIOACTIF PAR LE SANG ET LES EXSUDATS SEREUX. (Pharmacological Study of Radioactive-Gold Colloid Transport by Blood and by Serous Exudate). Rousselet, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1966. 126p. (In French). Dep.

Thesis. Submitted to Paris Univ.

The essential physico-chemical properties of colloids are discussed; consideration is also given to the biological role of these substances in connection with their transport by the blood and their capture by elements of the reticulo-endothelial system. The role of serous proteins in the transport of substances, particularly that of colloidal ^{198}Au, is summarized. The distribution of ^{198}Au in the blood fractions that take part in colloidal ^{198}Au transport (erythrocytes, leukocytes, and plasma) was obtained by autoradiography of blood sediments. The importance of the role of plasma in ^{198}Au transport was investigated using column chromatography and paper and gel electrophoresis. The in vitro and in vivo bonds between colloidal ^{198}Au particles and either the serous proteins of healthy specimens, the effusion liquids of pathological origin in man, or the inflammation induced by carregenin in rats, were studied. The bonding appeared to be effective because of the protective macromolecular layer formed by the gelatin. The different positions of the colloidal grains on the electrophorogram were explained by their different physico-chemical characteristics. Gold in the ionic form combined only with the albumins if the amount of metal present did not exceed a certain value. (B.H.S.)

32558 (CONF-661018, pp 98-116) DEPOSITION AND CLEARANCE OF RADIOACTIVE PARTICULATES IN THE TRACHEOBRONCHIAL TREE OF RATS. Spritzer, Albert A.; Watson, Joseph A.; Auld, Judith A.

An esophogeal collection technique for directly measuring tracheobronchial clearance in rats was developed. Using the technique, the kinetics of removal of ^{134}Cs-labeled ceramic particles from the lungs was examined during a time period that ranged from immediately after deposition to 5 days after exposure. Modifications in the positioning of the rats during and immediately following injection were used in an effort to alter the deposition pattern of the particles along the tracheobronchial tree. Results demonstrated that the technique served as a good method for determining tracheobronchial clearance and clearance rate data in the immediate exposure period and that the effects on mucociliary clearance of variables or stresses, such as gravity, that may influence either the deposition of particles or the mucociliary escalator mechanisms could be assessed. (B.H.S.)

32559 (CONF-661018, pp 191-207) METABOLIC DATA ON INJECTED AND INGESTED ^{234}Th IN HUMAN BEINGS. Maletskos, C. J.; Keane, A. T.; Telles, N. C.; Evans, R. D. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

The metabolism of soluble ^{234}Th after intravenous injection and of $^{234}Th(SO_4)_2$ after oral administration was studied. Five elderly human subjects, 3 males and 2 females, were injected intravenously with carrier-free ^{234}Th in isotonic citrate. Bioassay techniques used in the metabolic studies included radioactivity measurements on blood, urine, and feces, as well as whole-body γ-ray measurements (chair and scan), and partial body (upper 20%, including head and arms) measurements using a new skull and crossbones (SXB) position, by means of which the gastrointestinal tract was shielded with Pb. Whole body retention of Th was ~96% at 1 day, ~94% at 5 days, and ~90% at 2 months; the Th was excreted mainly in the urine. The cumulative urine-to-feces ratio at 5 days was ~12 for males and ~24 for females. The SXB measurements also indicated a sex difference, the amount of Th measured in the upper 20% of the body for the females being ~1.6 times greater than that for the males. Total blood retention of Th was ~10% at 1 day, ~1% at 5 days, and ~0.3% at 10 days. A second group of elderly subjects, 3 males and 3 females, were orally administered gelatin capsules containing $^{234}Th(SO_4)_2$, $^{224}RaSO_4$, and $BaSO_4$ carrier, deposited on ZnS phosphor to simulate original Ra dial paints. The same bioassay techniques used in the metabolic studies after injection of ^{234}Th, which provided calibration data for the absorption studies, were used to determine the transport of ^{234}Th across the gut wall. The average value for fractional ^{234}Th transport was $\leq$0.0003, the most probable value being 0.0002. Individual values ranged from 0.0001 to 0.0006. Cumulative fecal excretion of ^{234}Th was >98% of the administered dose for 4 subjects, and >90% for the remaining 2 subjects, at 4 days. Whole body γ measurements showed that cumulative excretion at 8 days was >99.8% for 5 subjects and ~98% for 1 subject. The implications of these findings to the internal dosimetry and radiation protection guides for thorium in man are discussed. (auth)

32560 (HUX-2643-34) AN INVESTIGATION ON THE MECHANISMS AND REGULATIONS OF NUCLEIC ACID AND PROTEIN SYNTHESIS, AND THEIR POSSIBLE RELATIONSHIP TO RADIATION DAMAGE. Progress Report, September 1, 1966–August 31, 1967. Zamecnik, Paul C.; Gardella, Joseph W. (Massachusetts General Hospital, Boston. John Collins Warren Labs.). Contract AT(30-1)-2643. 47p. Dep. CFSTI.

Progress is reported on studies of the synthesis of protein, with emphasis on ribonucleic acid and nucleotide metabolism. Data are reported from studies on the mechanism by which individual transfer ribonucleic acid molecules recognize their own aminoacyl ligases, and on the regulation of protein synthesis at the translation level. (C.H.)

32561 (NYO-3445-12) [EFFECT OF IONIZING RADIATION ON THE DISTRIBUTION OF DEOXYRIBONUCLEASES AND PHOSPHATASES IN SUBCELLULAR FRACTIONS OF GUINEA PIG EPIDERMIS]. Third Year Progress Report, August 14, 1966–April 15, 1967. Tabachnick, Joseph (Albert Einstein Medical Center, Philadelphia, Pa. Lab. of Experimental Dermatology). May 8, 1967. Contract AT(30-1)-3445. 19p. Dep. CFSTI.

Latent acid phosphatase activity was released from cell debris of non-irradiated and beta irradiated epidermis after treatment with the detergent, Triton X-100, suggesting that lysosomes were present in guinea pig epidermal cells. This finding was supported by the histochemical observation of minute acid phosphatase-rich granules in cells of nonirradiated epidermis and the presence of an increased number of larger granules in the cells of healed, regenerated tissue 30 days after 3000 rep beta irradiation. A heat-stable, dialyzable DNAase activator was present in epidermal washings and guinea pig blood. Adding increasing concentrations of plasma, sera, or heated epidermal wash, resulted in a rectangular hyperbolic curve for increasing activation of guinea pig hair extract DNAase. Attempts to determine activator concentration in the interstitial compartment of irradiated epidermis utilizing this curve indicated about a two-fold increase by the 6th day after 3000 rep beta irradiation. Both extracellular DNAase and hair extract DNAase were activated by added calcium ions in the assay mixture containing magnesium ions. Epidermal wash from nonirradiated and irradiated epidermis was assayed for DNAase activity in the absence and presence of calcium ions. Calcium ions activated both solutions, and it was concluded that postirradiation increases in epidermal calcium ion concentration played a minor role, if any, in accounting for the radioinduced increase in DNAase activity. (H.L.W.)

32562 (ORNL-P-3067) CYCLING OF ^{45}Ca BY DOGWOOD TREES. Thomas, William A. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 14p. (CONF-670503-11). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

Twelve flowering dogwood (Cornus florida L.) trees were stem-inoculated with ^{45}Ca in early May and studied until leaf abscission six months later. At the end of the experiment only 27% ± 3 of inoculum was in woody tissues (stems 11, branches 15, roots 1). Losses (as percentage of inoculum) were by leaf fall (64), foliar leaching (6), stemflow (≪1), and insect damage (3). Rapid turnover of inoculated calcium (73% ± 3) by these trees within a single growing season is further evidence that this species may be a nutritionally beneficial component of forest communities. (auth)

32563 (ORO-1637-14) THE ORIGIN AND FATE OF THIOCYANATE ION IN METABOLISM. Summary Progress Report, May 1954–May 1967. Wood, John L. (Tennessee Univ., Memphis. Dept. of Biochemistry). Contract AT(40-1)-1637. 11p. Dep. CFSTI.

The work of this project has established the following concepts: thiocyanate is a metabolic and chemical inhibitor of iodide reactions; is concentrated against the serum in the thyroid gland; and is metabolized to sulfate in the thyroid and other tissues containing peroxidases. The other product is cyanide ion. A transsulfuration system exists in mammalian and in bacterial tissues which utilizes mercaptopyruvate as a substrate. Protein persulfides are intermediates in the reactions of transsulfurase enzymes with their

substrates and in the action of alkali on proteins; persulfides have potential as antidotes for cyanide poisoning, as anti-radiation agents, and possibly as anticarcinogenes. Thiocyanoimidazoles are potent antithyroid agents. Thiocystine (β,β'-dialanine trisulfide) results from the action of cystathionase on cysteine and thiocystine is utilized by some transsulfurases; can replace cystine in the diet of the growing rat; and protects rats from an LD_{50} dose of cyanide. Cyanide is partially detoxified in the body by formation of iminothiazolidine-4-carboxylic acid. The product is inert metabolically. A thiocyanate-cyanide interconversion cycle exists in biological systems. Cyanide reacts with homocystine to form 2-iminotetrahydro-1,3-thiazine-4-carboxylic acid. The conversion of thiocyanate to cyanide in the red cells results from peroxidase activity. Proteins react with cyanide to form thiocyano derivatives with concomitant increased sulfhydryl groups. Thiocyanoproteins, and thiocyanopeptides, yield thiocyanate in alkaline solution and iminothiazolidyl-protein derivatives in mild acid. Iminothiazolidyl-protein derivatives decompose spontaneously to produce scission of the peptide link at the original cystine amino groups of the peptide chains. Methods were developed for the biosynthesis and chemical synthesis of radioactive cystine and methionine; resolution of radioactive racemates; determination of iminothiazolidine-carboxylic acid; and scission of the peptide link at cystine amino groups by cyanide. (33 references) (auth)

32564 THE BEHAVIOR OF MALATE DEHYDROGENASE (MDH), FDP ALDOLASE (ALD), AND PHOSPHOGLUCOSE ISOMERASE (PGI) IN SERUM TUMOR ILLNESSES DURING RADIOTHERAPY. Kato, Helena Toshi (Univ., Heidelberg). Strahlentherapie, 133: 42-51(May 1967). (In German).

Patients with malignant tumors were examined for changes in activity of different enzymes (malate dehydrogenase (MDH), fructosediphosphate aldolase, and glucosephosphate isomerase) during the course of x ray radiotherapy. The fluctuation of the enzyme activities, especially MDH, within the first hours after beginning of the treatment gave information about the radiosensitivity of different tumors. The aldolase and isomerase showed more parallelism to the course of the disease. The importance of the biochemical examinations in relation to radiotherapy was pointed out. (auth)

32565 RADIOIMMUNOASSAY OF BRADYKININ. Rinderknecht, H.; Haverback, B. J.; Aladjim, F. (Univ. of Southern California, Los Angeles). Nature (London), 213: 1130-1(Mar. 18, 1967).

Highly sensitive and specific radioimmunological methods were developed for the determination of many polypeptide hormones; such assays are usually based on the competitive reaction of a measured amount of the hormone labeled with radioiodine and varying amounts of unlabeled hormone with hormone antiserum. A radioimmunoassay technique for bradykinin, a monopeptide of considerable physiological and pathological importance, is described. Bradykinin differs from other polypeptide hormones that have been assayed by this method in that it lacks immunogenicity and is not accessible to iodination. Formation of antibody against this peptide was induced in goats by immunizing them with a bradykinin-haemocyanin conjugate. Labeling was introduced by acetylating the terminal amino-group with ^{14}C-acetic anhydride. Antiserum bound the acetyl bradykinin much more strongly than unacetylated bradykinin. An explanation offered was that at least part of the antibody formed was directed against a conjugate in which bradykinin was acylated by the carboxyl groups of haemocyanin. Such a derivative was deemed to be more chemically and immunologically related to acetyl bradykinin than the unacetylated peptide. The sensitivity of the assay was greatly increased by using tritiated acetyl bradykinin of higher specific activity. It was suggested that bradykinin derivative of still higher specific activity might be prepared by acylation with a group such as pipsyl labeled with radioiodine. (UK)

32566 ACTIVITY OF INTRACELLULAR PROTEINASES IN RAT THYMUS AFTER WHOLE-BODY GAMMA-IRRADIATION. Furlan, Miha (Josef Stefan Nuclear Inst., Ljubljana, Yugoslavia). Strahlentherapie, 133: 68-73(May 1967).

Proteolytic activity in rat thymus homogenates was measured using hemoglobin and histone substrates. The effect of 600 R whole-body γ-irradiation on the thymic proteinases was studied within 24 hours after exposure. An increased activity was demonstrated 12 and 24 hours after irradiation. A similar increase was also seen when involution of lymphoid tissue resulted from treatment with hydrocortisone. The possible mechanisms of the changes are discussed. (auth)

32567 CHANGES OF THE α-HYDROXYBUTYRATE DEHYDROGENASE AND THE LACTATE DEHYDROGENASE IN THE SERUM AND THE DIFFERENT ORGANS OF ^{60}Co AND X WHOLE-BODY-IRRADIATED RATS. Hornung, Guenter; Braun, Heribert; Bohndorf, Werner; Nahm, Hugo (Univ., Wuerzburg, Ger.). Strahlentherapie, 133: 52-62(May 1967). (In German).

Lactate dehydrogenase (LDH) and the α-hydroxybutyrate-dehydrogenase (HBDH) activities were determined in liver, heart, spleen, and serum of rats after whole-body irradiation with x rays as well as with ^{60}Co γ rays. Whole-body x-irradiation resulted in a decrease in activity of the LDH and HBDH in the serum and liver. An activity decrease for HBDH was also observed in heart and liver, while the activity of LDH was increased. Similar results, but to a lesser extent, were observed in the LDH and HBDH activities after whole-body γ irradiation. The greatest changes were observed on the 2nd day after x irradiation. Results led to the assumption that x-irradiation caused a greater damage to the organs than γ irradiation at the same dose. (auth)

32568 WHOLE-BODY RETENTION OF ^{137}Cs IN THE YOUNG AND ADULT MICE. Matsusaka, Naonori; Inaba, Jiro; Tsai, Chao-ming (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo), 16: 25-8(Jan. 1967).

Whole-body retentions of ^{137}Cs after a single intraperitoneal administration to the young and adult mice were studied to investigate the relations between the age of animal and body retention. The effect of age on the body retention was evident. The retention curves of the younger mice decreased more rapidly than those of older ages, and the younger animals had shorter biological half-times. The urinary and fecal excretions of ^{137}Cs in the young and adult mice were also studied. (auth)

32569 KINETICS OF THE PASSAGE OF SOLUBLE RADIOIODINE ACROSS THE RESPIRATORY EPITHELIUMS, AFTER INHALATION. Perrault, G.; Thieblemont, P.; Pasquier, Ch.; Marble, G. (CEN, Fontenay-aux-Roses, France). Health Phys., 13: 707-18(July 1967). (In French).

A kinetic study of the passage of iodine through the mucosa of the respiratory tract was undertaken by submitting monkeys to air contaminated with $Na^{131}I$. Though most of the inhaled particles were retained by the higher respiratory tract, the activity deposited on the alveolar epithelium was enough to allow a kinetic study of iodine resorption at this level. From the numerical data obtained a mathematical model was developed giving the biological half-life of lung and blood iodine. (auth) (UK)

32570 UNEQUAL GROWTH IN THE LOWER INCISORS IN A SINGLE RABBIT "BLACKIE". Starkey, W. E. (Royal Naval Medical School, Alverstoke, Eng.). J. Roy. Naval Med. Serv. (London), 51: 275-6(Winter 1965).

Information on the normal growth rate in the teeth of old rabbits was compared with results obtained after giving ^{90}Sr. It was found that while ^{90}Sr was incorporated to a lesser extent into the bones of old rabbits than in weanlings whose bones were still in a state of active growth, in the case of teeth, the position was reversed. In fact, with similar doses, the dental uptake increased with age. Since it is known that Sr is incorporated by the teeth in direct proportion to the rate at which calcification is taking place, this suggested that the teeth grow as fast in old rabbits as they do in young ones or even faster. The results not only confirmed that the rate of eruption was maintained until extreme old age, but also showed unequal growth between corresponding adjacent incisors. Records were kept of lower incisor growth in an 8-yr-old rabbit (Blackie). Readings were taken every three weeks on the basis of a small mark made on the lower incisors near the gingival margin and the distance measured to the previous mark which had advanced towards the biting edge during the intervening 21 days. The results showed that the rate of eruption was constant in the right incisor and slowly decreased with age in the left incisor. This contradicted the concept of mineral uptake increasing with age, except for the fact that the transverse dimensions of the teeth were increasing all the time. Thus, a constant or slightly reduced rate of linear growth could still represent an accelerating rate of mineralization. Under similar conditions of wear, the right tooth was always shortened more rapidly than the heavier left one and stayed in occlusion by making correspondingly faster growth. This is the first time this sequence of events has been reported except when it resulted from some artificial stimulus, and since the conditions of wear and tear were the same for both teeth, they are consistent with growth rate being dependent on attrition. (BBB)

32571 EFFECT OF MAGNESIUM ON RADIOSTRONTIUM EXCRETION IN MAN. Spencer, H.; Lewin, I.; Samachson, J. (Veterans Administration Hospital, Hines, Ill.). Int. J. Appl. Radiat. Isotop., 18: 407-15(July 1967).

The effect of intravenously administered magnesium on ^{85}Sr excretion was studied under strictly controlled dietary conditions in man. The results were compared with those obtained with equimolar amounts of calcium in the same patients. A single tracer dose of $^{85}SrCl_2$ was given intravenously in the control, the magnesium, and the calcium studies. Infusions of magnesium sulfate

or of calcium gluconate were given on the day of the intravenous injection of ^{85}Sr and on the subsequent two days. Both magnesium and calcium increased the urinary excretion of ^{85}Sr, but calcium was more effective than magnesium in most cases. The difference in effect appeared to be due to differences in urinary calcium excretion induced by intravenous calcium and magnesium, the infusions of calcium resulting in higher excretion of urinary calcium than the infusions of magnesium. There was no effect of either intravenous magnesium or intravenous calcium on fecal ^{85}Sr excretion. (UK) (auth)

32572 TRANSPORT OF RADIOIODIDE BETWEEN BLOOD AND THYROID OF CHICKENS. Newcomer, W. S. (Oklahoma State Univ., Stillwater). Amer. J. Physiol., 212: 1391-6(June 1967).

Experimental data concerning the increase in $T/S[I^-]$ (ratio of concentration of ^{131}I in thyroid to that in serum) during equilibration following a single injection of radioiodide were obtained from chickens in which organification of iodide was previously blocked by a single injection of methimazole. Equilibration data were obtained from control chickens as well as from chickens that had been treated with a low-iodine diet, high-iodine diet, thiouracil in feed, thyroxine injections, or a single injection of thiocyanate. The data were compared with predictions based on the open two-compartmental model of Wollman and Reed (Am. J. Physiol. 196: 113-120, 1959). Thyroidal clearance constants (C/m) for radioiodide varied considerably with experimental treatments. Exit rate constants (K_{TB}) were relatively more stable about a control value of 0.035 min^{-1} except after a single injection of thiocyanate wherein K_{TB} increased to 0.26 min^{-1}. Data concerning the dependence of $T/S[I^-]$ on serum iodide concentration were analyzed with the aid of modifications of an empirical equation (Am. J. Physiol., 186: 453-459, 1956). K_m was found to be 0.35 mg iodide/100 ml serum. Predictions based on the models fit the experimental data from chickens reasonably well. (auth)

32573 RELATIONSHIP OF MYOCARDIAL BLOOD FLOW AND ^{86}Rb CLEARANCE IN LEFT ATRIUM OF DOGS. Lyon, L. D.; Craig, M. C.; Davis, J. L.; McDaniel, D. C.; Love, W. D. (Univ. of Mississippi, Jackson). Amer. J. Physiol., 212: 1512-14(June 1967).

The rates of coronary blood flow in the left ventricle and left atrium were determined simultaneously by the Fick principle in dogs. Calculations were made using the final tissue isotope concentrations and the mean difference in arterial and venous radioactivity during a 10-min period of ^{86}Rb infusion. The mean rate of atrial blood flow was 8.3 ± 1.0 (SD) ml/g per 10 min. This was not significantly different from the rate of left ventricular blood flow in the same animals. The error in predicting the rate of atrial blood flow from a function representing the mean relationship of atrial blood flow and ^{86}Rb clearance averaged 8.7%. The relationship of blood flow and ^{86}Rb clearance in the left atrium differed significantly from that in the right and left ventricles. There was from 12 to 83% more blood flow at a given rate of clearance in 20 of 22 observations on the atrium. (auth)

32574 STUDY OF EDESTIN BY ULTRACENTRIFUGATION. Yang, Chi-chuen; Ou, Li-tse. Bull. Inst. Chem., Acad. Sinica, No. 13, 14-18(Apr. 1967).

The molecular weight and the sedimentation coefficient of edestin, a hemp protein, was determined by ultracentrifugal analysis. The sedimentation coefficient of the hemp protein depended on the concentration and the calculated molecular weight was around 334,000. Both γ-irradiated and nonirradiated edestin contained a small amount of a 19S portion; a heavier component of 25S was present in the irradiated sample. It was suggested that the 25S portion was an irradiation product that consisted of a complex of two molecules of edestin. The value of the sedimentation coefficient of the γ-irradiated edestin was proportional to the concentration, whereas the nonirradiated edestin gave reverse results. Results indicated that a change in molecular characteristic prevailed after γ-irradiation at 5×10^5 to 1×10^6 R. (B.H.S.)

32575 DETERMINATION OF SULFHYDRYL GROUPS IN YEAST CELL. Wai, Nganshou. Bull. Inst. Chem., Acad. Sinica, No. 13, 8-13(Apr. 1967).

Amperometric titration with dilute silver nitrate solution was used to determine the number of sulfhydryl groups contained in fresh yeast cells. Three species of yeast, Pichia farinosa, Saccharomyces cerevisiae, and Torulopsis utilis were tested. Aqueous suspensions of the yeast cells were disrupted by sonic vibration and then treated with 25 R x radiation for 3, 6, 9, or 12 min. The sulfhydryl group content decreased as the exposure time was increased. (B.H.S.)

32576 SPECTROPHOTOMETRIC STUDIES OF THE POST-IRRADIATION CONTENT OF DESOXYRIBONUCLEIC ACID (DNA) OF EPITHELIAL CELLS OF RAT CRYSTALLINE LENS. Busti, A.; Sorrentino, R.; Tognacca, M. L. (Ospedale Maggiore, Novara, Italy). Radiobiol. Lat., 7: 65-73(1964). (In Italian).

By means of a quantitative spectrophotometric method, a study was made of the variations of desoxyribonucleic acid (DNA) in the nuclei of the epithelial cells of the equatorial zone and of the polar zone of the lens in rats exposed to direct irradiation of the eye with a contact-irradiation apparatus. The animals were treated with doses of 1500 and of 3000 R in a single application and were killed 10 minutes, 6 hours, 24 hours, and 7 days after the treatment. The nuclear quantities were determined, with the nuclear volumes taken into consideration. Both types of cells showed a decrease in the amount of nuclear DNA within 10 minutes after the irradiation; this was more pronounced in the animals treated with a dose of 3000 R. Subsequently, the quantity of nuclear DNA gradually increased again. (auth)

32577 CYTOSINE HYDROPEROXIDE FORMATION IN γ RADIOLYSIS OF CYTOSINE IN AQUEOUS SOLUTION. Daniels, Malcolm; Schweibert, Mary Carol (Oregon State Univ., Corvallis). Biochim. Biophys. Acta, 134: 481-3(Feb. 28, 1967).

Evidence on hydroperoxide formation in γ-irradiated aqueous solutions of cytosine and quantitative data on its stability in relation to temperature and pH and its reactivity towards iodide are presented. In neutral and alkaline solutions of cytosine, no hydroperoxide could be detected, but at pH 2 a stable hydroperoxide was formed. The pseudo-first-order rate constant at several iodide concentrations and an evaluation of the second-order-rate constant as 1.7 M^{-1} sec^{-1} were determined by lowering the iodide concentration and using the expanded scale facility on a recording spectrophotometer. Results were similar to those reported for thymine, uracil, and dimethyluracil. (B.H.S.)

32578 CHROMATOGRAPHIC STUDIES ON RAPIDLY LABELED RNA PREPARED FROM ULTRAVIOLET-IRRADIATED PSEUDOMONAS EFFUSA. Harada, Y.; Nozu, K.; Honjo, I. (Osaka Univ.). Biochim. Biophys. Acta, 134: 452-4(Feb. 28, 1967).

Washed cell suspensions of Pseudomonas effusa were irradiated with ultraviolet radiation; the cells were pulse-labeled with 1μCi/ml of [8-^{14}C] adenosine and the rapidly labeled mRNA was then extracted. The distribution of adenine in digests of RNA obtained from irradiated cells was compared to that of nonirradiated cells. Results indicated that the base sequence of the rapidly labeled RNA transcribed from the DNA in the uv-irradiated cells was different from that in nonirradiated cells; slightly longer chains of adenine nucleotides were present in the mRNA formed in the uv-irradiated cells and guanine nucleotides played a role in the formation of the long chain purine nucleotides in the rapidly labeled RNA transcribed from the uv-damaged DNA. (B.H.S.)

32579 DETERMINATION OF THE NUCLEIC ACID CONTENT OF PROTOZOA BY ACTIVATION ANALYSIS. Akaboshi, Mitsuhiko; Maeda, Toshio; Waki, Asako (Kyoto Univ.). Biochim. Biophys. Acta, 138: 596-7(May 30, 1967).

Results are described of the determination of the nucleic acid content of Tetrahymena pyriformis, Euglena gracilis, and Amoeba proteus by activating the phosphorus of the nucleic acids. DNA and RNA were extracted using chlorine-free materials to avoid contamination with ^{32}P derived from ^{31}Cl. Sealed capsules of the dried extract were irradiated with a thermal neutron flux of approximately 4.10^{12} n/cm^2 sec for an hr. They were stored for 20 days after which γ emission by ^{24}Na was undetectable and the remaining radioactivity was due solely to ^{32}P and was counted. The results were essentially identical with chemical assays of the nucleic acids. (M.M.B.)

32580 THE ENTRY OF ^{24}Na FROM BLOOD INTO THE BRAIN OF MICE DURING 30 MINUTES AFTER INTRAVENOUS ISOTOPE INJECTION. Stulc, J. (Charles Univ., Prague). Life Sci., 6: 85-95(Jan. 1, 1967).

The sp act. of brain and plasma sodium was measured in mice from 1 to 30 min after intravenous injection of 10 μCi of ^{24}Na. The sp act. of plasma ^{24}Na was fitted to a curve which was solved in terms of its exponential components by graphical analysis. It was found that the sp act. of plasma ^{24}Na may be approximately characterized by the equation: $p = 2.7e^{-2.1t} + 0.3e^{-0.231t} + 0.91$, where p is the sp act. of plasma Na in 10^3 cpm/μEq Na and the unit of the rate constants is min^{-1}. From this expression, 2 hypothetical systems of brain Na compartments were computed. The first system consisted of a compartment for plasma Na and 3 compartments for brain Na. The size and the exchange rate of both slowly exchanging compartments were determined. The rapidly exchanging compartment represents the fraction of Na which could not be covered by either of the slow compartments. The second system consisted of a compartment for plasma Na and 2 slowly exchanging compartments for brain Na. The fraction of Na corresponding to the fast compartment in the first system was incorporated into the slow compartment with a half-time of 1 hr. The curve computed

for the first system fitted the experimental data fairly closely, while the curve computed for the second system did not fit at all. It was concluded that besides 2 slowly exchanging compartments for Na, another compartment, rapidly exchanging with plasma, is present in the brain of mice. (BBB)

32581 INVESTIGATION OF THE PRIMARY PHOTOCHEMICAL PROCESSES IN PROTEINS. IV. LUMINESCENCE SPECTRA OF PRIMARY AND END PHOTO PRODUCTS OF AROMATIC AMINO ACIDS AND PROTEINS. Vladimirov, Yu. A.; Ai-ke, Ho; Roshchupkin, D. I. (Moscow State Univ.). Biophysics, 11: 268-76(1966).

Translated from Biofizika, 11: 237-44(1966).

The luminescence spectra of primary products P_y (radicals) and the end products formed on irradiation with ultraviolet light of solutions of tyrosine, phenylalanine, tryptophan and allied compounds at 77°K were measured. The primary products of tyrosine and phenylalanine luminescing in the region 450 to 600 mμ were regarded as phenoxyl and benzyl radicals respectively. In the luminescence spectra of the tryptophan radicals at pH 6.0 and in ethanol two maxima were observed at 555 and 595 mμ and in alkaline medium an additional maximum appeared at 490 mμ. On softening the matrix the tryptophan radicals disappeared and they partly passed into stable products. In solutions of glycyl-dipeptides of aromatic amino acids and proteins the same radicals formed as in free aromatic amino acids. (auth)

32582 PARTICIPATION OF THE TRIPLET EXCITED STATE IN THE PHOTO REACTIONS OF THE PORPHYRINS AT 77°K. Gribova, Z. P.; Umrikhin, V. A.; Kayushin, L. P. (Inst. of Biological Phys., Moscow). Biophysics, 11: 400-3(1966).

The effect of interrupted illumination on the yield of free radicals in an ethanol solution of Mg-etioporphyrin at a concentration of 10^{-4} to 10^{-3}M and at a temperature of 77°K was investigated. Illumination of the sodium was carried out with the integral spectrum of a superhigh pressure mercury 500 w lamp through a thermal filter. Experiments were carried out in the absence of saturation in the region of sufficiently small light intensities. The τ phosph of Mg-etioporphyrin determined by the method of flash photolysis was 1.83×10^{-1} sec and from the attenuation of phosphoresence 1.6×10^{-1} sec. According to the equations derived for the calculation of the concentration of radicals under continuous illumination, the concentration of radicals was 16 times greater than that with interrupted illumination (duration of the pulse $T = 1.8 \times 10^{-2}$ sec) and 25 to 30 times greater at a pulse duration of 9×10^{-3} sec. It was concluded that the formation of free radicals in solid solution of Mg-etioporphyrin proceeded via the triplet excited state of the chromophore. Similar results were obtained with an ethanol solution of Zn-tetraphenylporphyrin. (B.H.S.)

32583 RADIOSENSITIVITY OF THE CHROMOSOMES OF HUMAN PERIPHERAL-BLOOD LEUKOCYTES AT THE DIFFERENT STAGES OF THE MITOTIC CYCLE. Dzhemilev, Z. A. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Genetika, No. 5, 67-78(May 1967). (In Russian).

Cultures of human peripheral-blood leukocytes were irradiated with a 100 R-dose of x radiation at the G_1-, S- and G_2-stages of the cell cycle. The frequency of chromosome aberrations was determined in metaphases and anaphases. The data showed that in X_1 the greatest number of chromosome aberrations was induced in cells irradiated at the G_2-stage. Cells irradiated at the S-stage were more radioresistant. Cells irradiated at the late and early G_1-stage had more aberrations than those irradiated at the S-stage. Among the aberrations induced by irradiation at the G_1-stage aberrations of the chromosome type prevailed; some aberrations of the chromatid type (chromatid bridges) were also observed. Most of the aberrations induced at the S- and G_2-stages were of the chromatid type. (auth)

32584 THE INFECTION OF LYSOZYME SPHEROPLASTS WITH THE ISOLATED DNA OF THE PHAGE T7. Danileichenko, V. V. (Inst. of Epidemiology and Microbiology, Moscow). Genetika, No. 5, 121-7(May 1967). (In Russian).

The main biological characteristics of DNA isolated from phage T7 were studied. From results obtained by an analysis of the character of a complex that was formed with acridine orange, enzymic analyses, kinetic studies on uv-irradiation inactivation, and thermal denaturation and sedimentation coefficient determinations it was concluded that the factor responsible for the synthesis of normal phage corpuscles in the sphereoplasts of bacteria was DNA. It was suggested that the higher resistance of DNA to the action of uv radiation, as compared to that of the intact phage, was due to the partially denatured state of DNA in the phage corpuscle and/or by additional damage that may have been inflicted on the protein component of the phage. Infectivity was successfully reproduced on spheroplasts obtained from a culture of bacteria that was at the mid-logarithmic growth stage; the concentration of sphereoplasts was 1 to 2×10^8/ml. The activity of phenol prepared DNA was 10 times higher than that of sodium perchlorate-treated DNA; 12×10^4 phago-equivalent units were attained. (auth)

32585 ROLE OF TRYPTOPHAN AND ITS METABOLITE IN RADIOBIOLOGY. Streffer, C. (Univ., Freiburg i. B.). Radiol. Clin. Biol., 35: 358-65(1966). (In German).

Several days after a whole-body x irradiation with 690 R (LD 80/30) the enzymatic activities of tryptophanhydroxylase and the decarboxylase of aromatic amino acids in the liver tissue of white mice were sharply depressed. Therefore a decreased biosynthesis of the important biogenic amine 5-hydroxytryptamine was indicated. The decreased content of the amine in the organs of irradiated animals is therefore explained. In the kynurenine decomposition of tryptophan, an enzyme distribution pattern occurs after irradiation such as is characteristic for the vitamin B_6 deficiency syndrome. The activities of the tryptophan pyrrolase and kynurenin aminotransferase are unaltered, but the kynureninase activity is decreased. On the basis of these changes, a reduced biosynthesis of pyridine nucleotides from tryptophan occurs. (tr-auth)

32586 IRRADIATION RESEARCH ON LIVER ALCOHOL DEHYDROGENASE IN AQUEOUS SOLUTION. Kopp, P. M. (Univ., Bern). Radiol. Clin. Biol., 35: 366-72(1966). (In German).

Studies on x-irradiated aqueous solutions of horse liver alcohol dehydrogenase showed that this enzyme is inactivated principally through the indirect radiation effect. Therefore, the concentration dependence, the dependence of the inactivation on the radiation dose, and the order of magnitude of the G values indicate the possibility of obtaining an effective radiation protection with various chemicals. (tr-auth)

32587 BIOCHEMICAL STUDIES ON ISOLATED NERVE ENDINGS AND OTHER PARTICULATES OF BULLFROG BRAIN. Abood, L. G.; Kurahasi, K.; Perez del Cerro, M. (Univ. of Rochester, N. Y.). Biochim. Biophys. Acta, 136: 521-32 (Apr. 25, 1967).

Bullfrog (Rana catesbeiana) brain was separated into its various subcellular fractions employing the technique of density-gradient centrifugation in Ficoll media. In addition to the mitochondria and an axonal-myelin fraction, a number of nerve ending fractions were obtained that differed in overall size as well as in the shape, size, and number of synaptic vesicles and mitochondria contained within. The fractions were analyzed for their lipid composition and distribution of oxidative and glycolytic enzymes. Studies of ^{32}P incorporation into subcellular components were carried out with the isolated brain that maintained its electrical excitability and its morphological and biochemical viability for several hours at room temperature. When Na^+ was replaced by K^+, ^{32}P phosphate incorporation into the various phosphates of the subcellular fractions was inhibited. Incorporation of ^{32}P into the ATP of the supernatant, nerve ending, and mitochondrial fractions was inhibited about 50%. Comparable inhibition was observed in the diphosphoinosihde and phosphoprotein fractions. (B.H.S.)

32588 EFFECT OF DEUTERATION OF THE O-CH_3 GROUP ON THE ENZYMIC DEMETHYLATION OF O-NITROANISOLE. Mitoma, C.; Yasuda, D. M.; Tagg, J.; Tanabe, M. (Stanford Research Inst., Menlo Park, Calif.). Biochim. Biophys. Acta, 136: 566-7(Apr. 25, 1967).

To test the hypothesis that complete deuteration of the O-CH_3 group of o-nitroanisole should substantially decrease the rate of oxidative demethylation, [Me-^{2}H]o-nitroanisole was prepared and its oxidation was studied in an in vitro system. Substitution of deuterium for hydrogen in the methyl group resulted in ~50% reduction in the rate of O-demethylation as evidenced by the ratio of the velocity constant (k_H/k_{H_3}) of almost 2 regardless of which product was measured. Determination of the Michaelis constants showed an average $k_m{}^3H/k_mH$ of 0.4 in three separate determinations; this indicated a stronger binding of the deuterated o-nitroanisole to the O-demethylating enzyme. The difference in the rates of metabolism between unlabeled and deuterated o-nitroanisole was considered to be due to differences in the rates of C-H and C-^{2}H bond breaking, i.e., a deuterium kinetic isotope effect. (B.H.S.)

32589 PREFERENTIAL PROTECTION OF THE REGULATORY FUNCTION OF PHOSPHORYLASE b AGAINST X-RAY INACTIVATION IN SOLUTION. Damjanovich, Sandor; Sanner, Tore; Pihl, Alexander (Norwegian Radium Hospital, Oslo). Biochim. Biophys. Acta, 136: 593-5(Apr. 25, 1967).

To determine whether or not the regulatory function of an allosteric enzyme could be preferentially protected against x radiation, the sulfhydryl enzyme phosphorylase b was irradiated in solution. The enzyme activity decreased as an exponential function of the radiation dose. When two of the sulfhydryl groups of the enzyme were blocked with p-perchlormercuribenzoate (PCMB) prior to

irradiation, a strong protection was found that corresponded to a dose reduction factor of about 2; blocking of two SH groups did not affect enzyme activity. To study the effect of radiation on the catalytic and allosteric sites, the Km values for the substrate, glucose-1-phosphate (G-1-P), and for the allosteric activator, adenosine-5'-monophosphate (AMP), were measured before and after exposure of the enzyme to 20 kR of x radiation. Irradiation caused a percentage increase in the Km of AMP that was more than 4 times greater than that of the Km of G-1-P, an indication that in phosphorylase b, the allosteric sites were more sensitive to x radiation than were the catalytic sites. The effect of x-irradiation on the Km values of PCMB protected phosphorylase b was measured; the percentage increase in the Km for G-1-P was found to be twice that of the untreated enzyme, while the increase in the Km for AMP was somewhat less than that for the untreated enzyme. These results indicated that PCMB treatment did not protect the binding sites for G-1-P but did protect the binding sites for AMP. It was suggested that x-ray inactivation of phosphorylase b in solution was largely due to a destruction of the binding sites for AMP. (B.H.S.)

32590 STROPHANTHIDIN-SENSITIVE TRANSPORT OF CESIUM AND SODIUM IN MUSCLE CELLS. Sjodin, R. A.; Beauge, L. A. (Univ. of Maryland, Baltimore). Science, 156: 1248-50(June 2, 1967).

Uptake of ^{134}Cs ions into muscle cells is reduced to very low values by the presence of 10^{-5}M strophanthidin in the Ringer solution. Cesium ions can induce extrusion of sodium from muscle cells in which the intracellular sodium content is elevated. The cesium-induced extra efflux of ^{22}Na is inhibited by the external presence of 10^{-5}M strophanthidin. The coupling between inward movement of cesium and outward movement of sodium appears to be chemical in nature. The evidence suggests that cesium ions are transported into muscle cells by a system of sites or carriers that requires a source of metabolic energy for ion turnover to occur. (auth)

32591 STUDIES ON THE RELATIONSHIP BETWEEN ^{131}I DEPOSITED ON PASTURE AND ITS CONCENTRATION IN MILK. Ekman, L.; Eriksson, A.; Fredriksson, L.; Greitz, U. (Research Inst. of National Defence, Stockholm). Health Phys., 13: 701-6(July 1967).

An experimental study is described with the main purpose of investigating the relation between a given deposition of ^{131}I on pasture and its concentration in milk from cows grazing on contaminated pasture. The ratio of the deposition of ^{131}I per unit area, pCi/m^2, to the concentration in milk, pCi/l, was found to be about 10. The results also indicate that there is a relation between the nutritive quality of the pasture and the levels of ^{131}I in the milk. Thus the highest concentration was reached when the quality was lowest. (auth)

32592 ELIMINATION OF 5μ PARTICLES FROM THE HUMAN LUNG. Booker, D. V. (Atomic Energy Research Establishment, Harwell, Eng.); Chamberlain, A. C.; Rundo, J.; Muir, D. C. F.; Thomson, M. L. Nature, 215: 30-3(July 1, 1967).

An apparatus is described that will provide a continuous and regular aerosol of 5μ particles of polystyrene labelled with chromium-51. The elimination of the radioactively labelled particles from the lungs after a single inhalation by human beings is followed by external gamma-ray measurements. (auth)

32593 EXPERIMENTS ON THE UPTAKE AND EXCRETION OF ^{131}I BY APHIS FABAE SCOP (APHIDAE, HOMOPTERA, INSECTA). Ehrhardt, P. (Univ. of Bonn); Lamb, K. P. Int. J. Appl. Radiat. Isotop., 18: 543-44(July 1967). (In German).

Measurements of uptake from artificial media and from cut bean leaves showed similar behavior, with count rate rising to a maximum after 4 to 5 days. Measurements of excretion were made in honeydew, shed skin, larvae, and saliva. The second and third of these showed the largest ^{131}I contents. (UK)

32594 EFFECTS OF IONIZING RADIATIONS ON THE FUNCTIONAL PROPERTIES OF ENZYMES. Coelho, R. (CEN, Saclay, Gif-sur-Yvette, France). Energ. Nucl. (Paris), 9: 189-94 (May 1967). (In French).

Ionizing radiations profoundly modify the functional properties of enzymes. The modifications were considered under three different points of view. First, the effects of irradiation on the kinetics of enzymatic reactions were examined; second, since the experimental conditions existing at the time of irradiation determined the effect produced, the influence of water and oxygen in particular were considered. Third, since the functional properties of the enzyme depended upon its structure, an attempt to relate the structural modifications induced by ionizing radiations to variations of the enzymatic activity was made. (auth)

32595 PROCEEDINGS OF SECOND INTERNATIONAL SYMPOSIUM ON INHALED PARTICLES AND VAPOURS, CAMBRIDGE, SEPT. 28th TO OCT. 1st 1965. Organized by British Occupational Hygiene Society. Davies, C. N. (ed.). Oxford, Pergamon Press, 1967. 605p. 7 pound.

The Conference included 48 papers, which are reproduced under the following sectional headings: anatomy and physiology, pulmonary response to dust; airway changes, pulmonary response to dust; reactions to silica, pulmonary response to dust; miscellaneous lung clearance in animals; lung deposition and clearance in man; dust in human lungs; relationship in pneumoconiosis of dust to response; and evaluation of dust exposure. Discussions are included. Separate abstracts are given for 6 papers. (UK)

For abstracts of individual papers see: 32596–32600 and 32771.

32596 SHORT-TERM LUNG CLEARANCE IN RABBITS EXPOSED TO A RADIOACTIVE BI-DISPERSE (6 AND 3 μ) POLYSTYRENE AEROSOL. Holma, Bo (Karolinska Institutet, Stockholm. National Inst. of Public Health, Stockholm). pp 189-203 of Proceedings of Second International Symposium on Inhaled Particles and Vapours, Cambridge, Eng., Sept. 28th to Oct. 1st 1965. Oxford, Pergamon Press, 1967.

A technique is described for external measurement which can be used for studying the rate of lung clearance for two monodisperse aerosols, a bi-disperse aerosol, simultaneously in a single animal. Using this technique, the lung clearance of 6 μm and 3 μm polystyrene particles tagged with ^{198}Au and ^{46}Sc respectively was studied in eight rabbits for 48 hours after exposure. The results show that the clearance rate is faster for the larger than for the smaller particles. (auth)

32597 BIOLOGICAL STUDIES ASSOCIATED WITH A FIELD RELEASE OF PLUTONIUM. Wilson, R. H.; Terry, J. L. (Univ. of Rochester, N. Y.). pp 273-90 of Proceedings of Second International Symposium on Inhaled Particles and Vapours, Cambridge, Sept. 28th to Oct. 1st 1965. Oxford, Pergamon Press, 1967.

Three hundred dogs, sheep, and burros were exposed to the plutonium aerosol generated by a high-explosive detonation. Initial lung burdens for the three species were 22.6, 10.6, and 17.7% of the respirable (<10μ) particles, respectively, and of these burdens 67, 5.1, and 22% were cleared slowly. Early clearance showed half-times of 4, 5, and 10 days, but the data were inadequate to establish a slow clearance half-time different from the usually accepted 365 days. Ten dogs and ten sheep were exposed to a similar aerosol in concert with a large amount of inert dust; these animals showed 4 to 5 times greater clearance in the first seven days. No data are available for extrapolation beyond seven days. (auth)

32598 NON-EQUILIBRIUM TISSUE DISTRIBUTIONS OF URANIUM AND THORIUM FOLLOWING INHALATION OF URANIUM ORE BY RATS. Stuart, B. O.; Beasley, T. M. (Battelle Memorial Inst., Richland, Wash.). pp 291-8 of Proceedings of Second International Symposium on Inhaled Particles and Vapours, Cambridge, Sept. 28th to Oct. 1st 1965. Oxford, Pergamon Press, 1967.

If each radioactive daughter comprising the uranium decay chain is considered individually, those daughter products such as ^{230}Th having unusually high pulmonary retention may contribute to a lower calculated permissible limit for uranium ore than that based solely on the levels of insoluble natural uranium. In order to determine whether such a lower limit is valid from a hazard viewpoint it is necessary to know whether the given daughter (^{230}Th) does indeed have a high retention when inhaled with the parent radionuclide as a constituent of uranium ore. Both single and repeated exposures of rats to high grade (25% U_3O_8) pitchblende ore resulted in increasing thorium-to-uranium ratios in the lungs with increasing times post-exposure. Highly sensitive analytical procedures (allowing precise measurements on 10 μg of ore) showed significant departures from initial equilibrium levels as little as one week after three 2-hr exposures, rising to a ratio of nearly three after 8 weeks. During repeated exposures over two months a gradual rise in mean thorium-to-uranium ratios to 2.5 was observed, in spite of the repeated deposition of fresh ore (in secular equilibrium). The ratio was found to be about nine in the lungs of animals sacrificed four months after the last exposure. These data suggest a preferential retention of thorium in the lungs. Analyses of bronchial and mediastinal lymph nodes also showed selective accumulation of thorium, while initial uranium concentrations in the kidneys were higher than those of thorium. Femurs and livers also accumulated higher thorium radioactivities. (auth)

32599 A STUDY OF THE RETENTION AND SUBSEQUENT METABOLISM OF INHALED METHYL IODIDE. Morgan, A.; Morgan, D. J.; Arkell, G. M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 309-21 of Proceedings of Second International Symposium on Inhaled Particles and Vapours, Cambridge, Sept. 28th to Oct. 1st 1965. Oxford, Pergamon Press, 1967.

Radioiodine released from irradiated uranium is predominantly in the elemental form, but a small amount is usually released as methyl iodide. In order to enable estimates of the radiological hazard resulting from the inhalation of radioactive methyl iodide to be made, measurements of its retention in a number of volunteer subjects were carried out, using iodine-132-labeled methyl iodide. At normal breathing rates the retention varied from 53 to 92%, depending principally upon the respiratory rate (breaths per minute), low rates corresponding to high retention, and vice versa. The mean value for retention was 72%. Studies of the clearance of radioactive methyl iodide from the lung showed that its uptake into pulmonary blood and removal to other parts of the body in the general circulation is extremely rapid. The metabolism of iodine-132 introduced as methyl iodide was found to be very similar to that observed after oral intake of iodine-132 as inorganic iodide. It may be concluded that the retained methyl iodide is broken down quite rapidly and that the liberated iodide participates in normal iodine metabolism. (auth)

32600 THE CLEARANCE OF RADIOACTIVE PARTICLES FROM THE HUMAN LUNG. Albert, R. E.; Lippmann, M.; Spiegelman, J.; Strehlow, C.; Briscoe, W.; Wolfson, P.; Nelson, N. (New York Univ. Medical Center, N. Y.). pp 361-78 of Proceedings of Second International Symposium on Inhaled Particles and Vapours, Cambridge, Sept. 28th to Oct. 1st 1965. Oxford, Pergamon Press, 1967.

Seventeen clearance studies by external gamma counting were made on eleven subjects who inhaled, by mouth, 3 and 5 μ iron oxide particles tagged with ^{51}Cr and ^{198}Au. The clearance curves obtained, which were very similar to the curves obtained in an earlier study utilizing heterodisperse iron particles (Albert and Arnett), demonstrated that rapid clearance was completed within 1 day and in most cases within 12 hr. In most subjects upper respiratory tract clearance occurred in two distinct phases, of about 2 and 10 hr duration. The two phases of bronchial clearance probably represent the clearance of particles from the proximal and distal parts of the bronchial tree. Estimates of the deposition of 3 and 5 μ iron oxide particles in the upper and lower parts of the respiratory tract were based on the ratios of the residual lung burden at a post-inhalation time of 24 hr to the initial lung burden. These estimates differed substantially from those obtained by measurement of particle and carbon dioxide concentrations in serial subfractions of exhaled air. Comparable values for upper and lower respiratory tract deposition were obtained with detectors having widely differing counting geometries, indicating that the lung behaves fairly homogeneously with respect to particle clearance. Preliminary data suggest that bronchial clearance is not retarded in heavy cigarette smokers. (auth)

32601 THE GENETIC CODE. Cold Spring Harbor Symposia on Quantitative Biology, Cold Spring Harbor, N. Y., June 2-9, 1966. Frisch, Leonora (ed.). Cold Spring Harbor Symp. Quant. Biol., 31: 1-762(1966). (CONF-660653).

The proceedings of the annual symposium consists of a collection of 88 papers and discussions on codons in vitro, directions of reading, polarity, punctuation, control of gene expression, transfer RNA (chemistry, functions, and interactions), ribosome and transfer RNA, and origins of the code. A separate abstract was prepared for one paper. (M.M.B.)

For abstracts of individual papers see: 32602.

32602 END-GROUP LABELING OF NUCLEIC ACIDS BY ENZYMATIC PHOSPHORYLATION. Weiss, Bernard; Richardson, Charles C. (Harvard Medical School, Boston). Cold Spring Harbor Symp. Quant. Biol., 31: 471-8(1966).

From Cold Spring Harbor Symposia on Quantitative Biology, Cold Spring Harbor, N. Y., June 2-9, 1966. See CONF-660653.

A recently discovered enzyme, polynucleotide kinase, has proved to be a valuable reagent for end-group labeling of nucleic acids without some of the limitations of other methods. The enzyme is isolated from phage infected Escherichia coli and acts as a catalyst for the transfer of a phosphate group from ATP to the 5'-hydroxyl termini of polynucleotides. Labeling of these termini of DNA and RNA molecules with ^{32}P has been used to study their 5'-terminal residues. The results of the use of the method for the study of bacteriophage DNA are reported. (M.M.B.)

Ecology

Refer also to abstracts 32652 and 32737.

32603 (ORNL-P-3065) TROPHIC LEVEL CONCENTRATIONS OF ^{137}Cs, SODIUM, AND POTASSIUM IN FOREST ARTHROPODS. Reichle, David E.; Crossley, D. A. Jr. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 21p. (CONF-670503-10). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

In a forest ecosystem experimentally tagged with ^{137}Cs, the trophic dynamic aspects of arthropod food chains are being investigated using radiotracer techniques. Cesium-137 concentrations in organisms in isotopic equilibrium with food showed progressive reduction during dispersion through food chains, although the fractional transfer between food and consumer increased with each successive trophic level. The distribution of other alkali metals in arthropod food chains varied from that of cesium. Potassium concentrations in primary consumers (saprovores) were a factor of 3.5 higher than in detritus, although they decreased (similar to ^{137}Cs) by a factor of 0.5 from primary consumers to predators. Sodium concentrations in primary consumers increased by a factor of 17 above leaf litter, and by an additional factor of 1.5 in predators. There were no significant differences in ^{137}Cs to K ratios between arthropod trophic levels. Changing elemental composition of litter during decay, nutrient availability and assimilation efficiency by arthropods, and biological half-lives of each element were parameters affecting absolute concentrations and ^{137}Cs to K ratios in each trophic level. (auth)

Genetics and Cytogenetics

Refer also to abstract 32798.

32604 (COO-1300-13) ANNUAL REPORT OF RESEARCH [ON GENETIC ORGANIZATION OF THE COMPLEX R REGION IN MAIZE]. Brink, R. A.; Kermicle, J. L. (Wisconsin Univ., Madison). Apr. 1967. Contract AT(11-1)-1300. 11p. Dep. CFSTI.

Genetic organization of the complex R region in maize is being studied through analysis of changes in R properties arising in three ways: spontaneously by mutation, by paramutation, and by induced modification of the paramutation process through x radiation and chemical mutagens. The studies are designed to reveal the number, kind, and functional relationships of the numerous components which comprise the locus. Colorless seed, R~, mutations are being studied through analysis of variation arising spontaneously. Studies are being conducted on the dependence of the change in paramutagenic action accompanying stippled (R^{st}) to self-colored (R^{sc}) mutation upon crossover origin of the mutation. Paramutation studies are being made on plants grown from diethyl sulfate treated seed. The effects of x rays and gamma rays on paramutation in plants are being investigated. (H.L.W.)

32605 (STI-PUB-129) MUTATIONS IN PLANT BREEDING. Panel Proceedings Series. Proceedings of a Panel held in Vienna, 17-21 January 1966. (International Atomic Energy Agency, Vienna (Austria)). Dec. 1966. 282 p. IAEA: $6.00; S 155,-; Pound 2.2.4; F Fr 29,40; DM 24,-.

Twenty-two papers (21 English and 1 French) are included. There are, among others, papers on methods of inducing mutations in crop plants, genetics and nature of induced mutations, the use of mutations in plant breeding, nature and use of induced translocations, quantitative analysis of induced mutation, and recommendations on mutation research problems and efficient practical use of the induced mutation technique. Of these 8 have been individually abstracted. (M.M.B.)

For abstracts of individual papers see: 32607-32614.

32606 POLYPLOIDY IN HUMAN LEUCOCYTE CULTURES TREATED WITH CYSTEAMINE AND IRRADIATION. Jackson, J. F.; Hill, F. S. (Univ. of Mississippi, Jackson). Nature (London), 214: 1155-6(June 10, 1967).

Both irradiation and cysteamine induce polyploidy in human leucocyte cultures stimulated by phytohaemagglutinin. Studies are described to determine whether the effects are competitive or additive. X-irradiations of 200 and 400 R were employed at 83 R/min. Metaphase mitoses were examined for the determination of ploidy. The experimental technique is described and results tabulated. The combined treatment usually resulted in higher percentages of polyploidy than the sum of percentages in cultures with either treatment alone. This suggests that the combined treatment is at least additive, and may be synergistic. Mechanisms are discussed. The development of polyploidy may be an effect common to both irradiation and radioprotective agents in general, and may be irrelevant to the immediate survival of tissue culture cells or of irradiated animals protected by such agents It therefore becomes a factor of importance in the proposed use of chromosome aberrations as biological dosimeters. It may also be of importance in considering the use of radioprotective agents as adjunctive therapy along with massive therapeutic irradiation, in view of the suggestion that previously irradiated tumors may become radiation resistant because of an increase in ploidy. (UK)

32607 STUDIES ON RADIATION-INDUCED MUTATIONS IN QUANTITATIVE CHARACTERS OF WHEAT (TRITICUM VULGARE). Borojevic, K. (Faculty of Agriculture, Novi Sad, Yugoslavia). pp 15-38 of STI-PUB-129.

A survey was made of the quantitative characters of bearded mutants in the M_7 and M_8 generations selected from nonbearded wheat varieties treated with x rays and thermal neutrons in a macromutation experiment and of the induced mutations in the quantitative characters of morphologically normal plants in the micromutation experiment according to Gaul's terminology. The seeds were irradiated with 15,000 R and thermal neutron doses of 1.38×10^{13} and 8.71×10^{12} (flux 5.91×10^{9}). It was concluded that the irradiation caused changes in the mean values and variability of the quantitative characters. In the case of micromutation, selection was needed in order to detect the changes in the irradiated material and to allow phenotypic expression of the selected genotype in the desired direction. (M.M.B.)

32608 INDUCTION OF MUTATIONS IN BARLEY: SOME PRACTICAL AND THEORETICAL RESULTS. Haensel, H. (Hochschule fuer Bodenkultur, Vienna). pp 117-37 of STI-PUB-129.

Various data were collected on the effectiveness of different mutagenic treatments, the storage effect in irradiated seeds, the segregation of mutant alleles, screening techniques, the pleiotropic effects of a single locus and the yield performance of "beneficial" mutant lines. Some of these data which appear to be of a more general interest are discussed briefly. (auth)

32609 INDUCTION OF MUTATIONS BY PHYSICAL AND CHEMICAL MUTAGENIC AGENTS. Heslot, H. (Institut National Agronomique, Paris). pp 139-49 of STI-PUB-129. (In French).

Mutagenic agents of the following groups were synthesized: cyclic ethers, nitrogen mustards, sulfates and sulfonates, ethyleneimines, and nitrosoamines. The effects of nitrosomethylurethane and nitrosoethylurethane on the chromosomes of barley and Vicia faba were studied and compared with the effects of radiation. Studies on the genetics, biochemistry, and enzymology of the yeast, Schizosaccharomyces pombe, were continued. Experimental studies on mutations of the herbs, Tagetes erecta and T. patula, were conducted. Somatic mutations were induced in barley and roses by radiations and chemical mutagens. (H.L.W.)

32610 THE GENETIC NATURE OF PHENOTYPIC REVERSIONS INDUCED IN HORDEUM WITH IONIZING RADIATIONS AND CHEMICAL MUTAGENS. Tuleen, N. A.; Caldecott, R. S.; Snyder, L. A.; Hiatt, V. S. (Univ. of Minnesota, St. Paul). pp 45-8 of STI-PUB-129.

A mutation (yv) which represses normal chlorophyll production in barley can be overcome by both dominant and recessive mutations. The recessive mutations were induced with both ionizing radiations and ethylmethanesulfonate (EMS) and those studied are all suppressors. The x-ray induced suppressors can be ascribed to a number of different chromosomes but several instances of mutation have involved the same locus. The dominant revertants have all arisen from EMS treatment. They are incompletely dominant in that the F_1's from a cross between them and homozygous yv lines express pigment development that is intermediate between the two parents. Whether they are true back mutations or dominant suppressors is not yet known. (auth)

32611 BARLEY CYTOGENETICS AND BREEDING (A PROGRESS REPORT). Nilan, R. A. (Washington State Univ., Pullman). pp 177-85 of STI-PUB-129.

The objectives of the research on this contract are as follows: (1) To study the response of specific loci in isogenic backgrounds to chemical and physical mutagens. (2) To determine the influence of mutagens on genetic recombination. (3) To develop through use of mutagens an extensive set of inversions to be used in chromosome engineering and for increasing interchromosomal recombination. (4) To use physical and chemical mutagens to induce beneficial mutations for development of new varieties. (5) To analyze genetically and cytologically induced mutant strains. During the past 1½ years some progress has been made on all five objectives of the contract. (auth)

32612 SEED RADIOSENSITIVITY. Osborne, T. S. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-Gen-242. pp 187-9 of STI-PUB-129.

Various aspects of research on radiosensitivity of seeds are discussed. The effects of gamma rays and fast neutrons are mentioned. Moisture uptake has been found to be an important variable affecting radiosensitivity. Work on organization and development of barley embryos is described. The use of the Oak Ridge Health Physics Research Reactor (HPRR) for fast-neutron seed-irradiation is discussed. (M.M.B.)

32613 RESEARCH ON MUTATION BREEDING IN DURUM WHEAT. Scarascia-Mugnozza, G. T. (Comitato Nazionale per l'Energia Nucleare, Rome). pp 191-6 of STI-PUB-129.

The genetics, cytogenetics, mutagenesis, and radiosensitivity of durum wheat were studied. Dry seeds were irradiated with x rays (10-30 kR), thermal neutrons ($8.38-16.4 \times 10^{12}$ n/cm^2), and fast neutrons (132-729 Rep), or treated with alkylating agents. Of about 100,000 seeds treated (1956-59) about 10,000 fertile M_1 plants were grown. Mutants were selected visually in M_2 and confirmed in M_3. Some of the most promising mutants are those characterized by culm shortening, lodging resistance, increased spike and spikelet fertility, and decreased yellow berry incidence. It is concluded that in an autogamous and polyploid species such as durum, visual selection of mutants for breeding programs is feasible. (M.M.B.)

32614 STUDIES ON THE INDUCTION OF NEW GENETIC VARIABILITY FOR QUANTITATIVE TRAITS BY SEED IRRADIATION AND ITS USE FOR WHEAT IMPROVEMENT. Scossiroli, R. E.; Palenzona, D. L.; Scossiroli-Pellegrini, S. (Univ. of Bologna). pp 197-229 of STI-PUB-129.

The Cappelli and Damiano varieties of wheat were used in studies to determine the possible use and efficiency of radiation treatments for increasing genetic variability of quantitative traits of crop plants. Seeds were x-irradiated with 10 and 20 kR. The latter dose proved to be lethal. Subsequent generations were obtained by sampling among the seeds from the self-fertilized main spike of the preceding generation and noting the pedigree. It was found that any major change in a given character was followed by a change in fitness which could only be balanced by time and selection. Radiation injuries also required several generations for recovery, and the effects on the seed embryo phenotype before breeding work could be started confused the genetic changes. (M.M.B.)

32615 CONGENITAL BILATERAL CORNEO-IRIDO-CHOROIDO-RETINAL COLOBOMA ASSOCIATED WITH CARDIO-VASCULAR ANOMALIES. Zolog, N. (Clinica Oftalmologica, Timisoara, Roumania). Ann. Ocul. (Paris), 199: 885-95 (Sept. 1966). (In French).

Congenital abnormalities in a 2-day-old boy are described and are attributed etiologically to chronic exposure of the boy's father to x rays as a result of his profession, a medical radiologist. The child presented various ocular anomalies (oval, partly plane, and opaque cornea, bilateral congenital iridoretino-choroidal coloboma) associated with cardiovascular anomalies (aplasia of the pulmonary artery, interatrial communication, stenosis of the tricuspid valve). Histologic investigation of one eyeball, enucleated after the child's death that occurred on the fifth day after birth, disclosed some unusual structures in the cornea, uvea, and retina. The type of corneal opacity found is very rare, as is the association of corneal anomalies with uveoretinal coloboma. The contours of the corneal opacity and its bilateral nature, are quite different from any reported in the literature. Embryogenesis of the defects are traced and are ascribed to radioinduced changes in the germ cells of the father. (BBB)

32616 INVESTIGATIONS ON THE INFLUENCE OF 5-BROMOURACILDESOXYRIBOSIDE (BUdR) ON THE RADIOINDUCED MUTATION RATE IN DROSOPHILA MELANOGASTER. Magdon, Erwin; Winterfeld, Gisela (Institut fuer Krebsforschung, Berlin). Strahlentherapie, 133: 137-48 (May 1967). (In German).

Using male Drosophila melanogaster of the Berlin wild strain, the effect of 5-bromo-2'-deoxyuridine (BUdR) on the x-radioinduced rate of recessive and sex-linked lethal factors was investigated in different stages of spermatogenesis. It was shown that the mutation rate induced by irradiation with 1500 R was significantly increased in spermatogonia, when BUdR was given after irradiation; BUdR was not effective in sperm when administered prior to irradiation. A possible explanation seemed to be that BUdR incorporation into the DNA, sufficient for a significant increase of the radioinduced mutation rate, was possible only in germ cells that synthesize DNA, and after a radiation induced inhibition of the thymidylate synthesis. (auth)

32617 STUDIES IN THE KARYOTYPE OF PERIPHERAL BLOOD, BONE MARROW, AND TUMOUR CELLS IN TWO CASES OF MULTIPLE MYELOMA FOLLOWING THERAPEUTIC IRRADIATION. Dubrova, S. E. (Inst. of Cytology, Leningrad). Genetika, No. 6, 54-61 (June 1967). (In Russian).

Cytogenetic studies of the cells of peripheral blood, bone marrow and tumour in two patients suffering from multiple myeloma were carried out. A clone of cells with 42 chromosomes was found in a tumour consisting of myelomatose cells. The model chromosome number in blood cells of this patient (male patient Z.) after 48 hours' cultivation was normal, but various chromosome re-

arrangements were observed in these cells, such as breaks, fragments, translocations and dicentrics, which, apparently, is the result of the therapeutic x-ray treatment of the tumor region. In the blood cells of the other patient (female patient S., 48 hours' culture) there was also a high frequency of chromosome rearrangements after 32 months of the therapeutic x-ray treatment in the region of the first lumbar vertebra at a total dose of 9000 R. The prevalent types of aberrations were the chromatid rearrangements in different groups of chromosomes. In the male patient Z. the karyotype of the bone-marrow cells before and after the treatment with cytostatic preparations was normal, while in the female patient S. the appearance of some polyploid cells was observed. (auth)

32618 SPECIFICITY OF THE ACTION OF IONIZING RADIATION ON THE CHROMOSOMES OF ANIMALS AND PLANTS. Demin, Yu. S.; Sidorov, B. N.; Sokolov, N. N. (Inst. of General Genetics, Moscow). Genetika, No. 6, 10-18(June 1967). (In Russian).

A comparison is made of the spectrum of single-hit chromatid rearrangements induced by x rays in plant and mammalian cells. Aberrations in the cells of humans, Chinese hamster, Vicia faba, Crepis capillaris and Tradescantia were studied. The following differences between plant and mammalian cells were observed: In mammalian cells the frequency of terminal deletions exceeded significantly that of iso-locus deletions, being, on the contrary, lower in plant cells. The differences in the behavior of the broken chromatid ends were observed; thus, the junction of the ends of broken chromatids was more frequent in plant cells than in animal cells. In plant cells the number of gaps was shown to be 2.4 times the number of breaks, while in mammalian cells the same ratio was 1:3. It is quite possible that in the cells of mammals the process of chromosome damage was more similar to the primary damage than it was in plant cells. It was concluded that the differences observed were possibly associated with the specific molecular features of the mechanism of chromosome strand breakage and/or with the differences in the physiological activity of plants and animals. (auth)

32619 THE TIME OF THE BEGINNING OF DNA SYNTHESIS IN THE GERMINATING SEEDS OF CREPIS CAPILLARIS. Protopopova, E. M.; Shevchenko, V. V.; Generalova, M. V. (Inst. of General Genetics, Moscow). Genetika, No. 6, 19-23(June 1967). (In Russian).

Seeds of Crepis capillaris were placed into a solution of ^{3}H-thymidine at equal time intervals for the determination of the beginning of DNA synthesis. The roots of the seedlings grown from the seeds that germinated in 24, 30 and 36 hours were fixed and the proportion of cells with tagged nuclei was determined in the squashed preparations stained after Feulgen. It was observed that the DNA synthesis in the early-germinating seeds began in 8 to 10 hours after the beginning of the soaking of the seeds in the thymidine solution, and after 14 to 16 hours in those germinating after the elapse of 36 hours. No difference was observed in the time of the onset of DNA synthesis between the control seeds and those irradiated by x rays at a dose of 4000 R. A direct dependence between the beginning of the synthesis of DNA on the one hand and the radiosensitivity and the rate of seed germination on the other hand was established. The highest frequency of chromosome rearrangements was observed in the early-germinating seeds. (auth)

32620 QUANTITATIVE VARIATION IN ARABIDOPSIS THALIANA INDUCED BY IONIZING RADIATIONS. Brock, R. D. (CSIRO, Canberra, Australia). Radiat. Bot., 7: 193-203(June 1967).

The effect of γ-rays and thermal neutrons on morphological and quantitatively inherited characters was studied using an early flowering race of Arabidopsis thaliana. Both mutagens induced visible mutations and variation in flowering time and plant weight. There were negative phenotypic and genetic correlations between the induced flowering time and plant weight variation. Selection responses were achieved for both early and late flowering. The response, however, was skewed towards lateness. The mean plant weight of the late flowering selections was reduced. A selection response for increased growth rate was achieved in the γ-ray treated population. This selected population flowered earlier, whereas random selections flowered later than the untreated control. These results support the hypothesis that random mutation results in an increase in variance for quantitative characters which can be utilized by selection. They also indicate that the mean of a character not subjected to selection after the induction of mutation will be determined by its previous selection history and by any genetic correlation existing between it and a character under selection. Such correlated responses may enhance or oppose the effect of mutation on the mean of the character. (UK) (auth)

32621 CONCERNING THE DYNAMICS OF CHROMOSOME REPLICATION AND DEGRADATION IN A BACTERIAL POPULATION EXPOSED TO X RAYS. Billen, Daniel; Hewitt, Roger (Univ. of Texas, Houston). Biochim. Biophys. Acta, 138: 587-95(May 30, 1967).

Successive radioisotopic labeling of the Escherichia coli chromosome has been employed to determine whether the position of the label at the time of exposure to x rays influences its pattern of replication subsequently. Following exposure to 5000 R of x rays the chromosome region in front of the "replication-fork" at the time of exposure is replicated to a greater extent than the region in or immediately behind the growth point. The latter region is prematurely replicated. If after x ray exposure prevention of new cycles of DNA synthesis is accomplished by incubation of the cells in medium lacking required amino acids then the replication of all regions is markedly depressed. In addition an enhanced, non-selective degradation of chromosome regions is observed when irradiated cells are incubated without amino acids. Thus DNA in the vicinity of the replication-fork is degraded to the same extent as DNA located elsewhere. The data are interpreted as showing that following irradiation there exist two populations of chromosomes, the proportions of which are dose dependent. One population responds normally in regard to replication sequence and results from the resumption of semiconservative replication by the original replication-fork. The other, having lost its integrity, shows an aberrant type of replicative synthesis in which new sites of replication are initiated at random locations. (auth)

32622 EFFECT OF X RAYS ON THE CHROMOSOMES OF CHROTOGONUS INCERTUS BOLIVAR (ACRIDIDAE). Srivastava, M. D. L.; Bachher, K. S. (Allahabad Univ., India). Caryologia, 19: 513-21(Oct.-Dec. 1966).

Specimens of Chrotogonus incertus were exposed to 400, 500, and 800 R and spermatocytes were examined twenty-four hours subsequent to exposure. Exposure to 800 R caused aggregation of chromosomes into large vacuolated masses, which were unequally divided between the secondary spermatocytes. Another effect was extreme fragmentation of chromosomes. Exposure to 400 and 500 R caused comparatively moderate aberrations—lagging and incomplete breaks. (auth)

32623 INDUCTION OF MUTATIONS BY ULTRAVIOLET IRRADIATION OF SPORES OF BACILLUS SUBTILIS. Zamenhof, Stephen; Reddy, T. K. R. (Univ. of California, Los Angeles). Radiat. Res., 31: 112-20(May 1967).

Ultraviolet irradiation of spores of Bacillus subtilis has been found to be an efficient mutagenic procedure; the mutant frequency was lower ("total auxotrophs") or the same (revertants) when compared with ionizing radiation for spores at comparable survival. At lower survivals the frequency of mutants induced in spores by UV reached a plateau ("total auxotrophs") or a plateau followed by further increase (revertants), which is consistent with the hypothesis that the efficiency of the mechanism of repair of UV-induced mutagenic lesions changes with an increasing number of lesions. The spores of a sulfanilamide-resistant mutant that were previously found to be less resistant to ionizing radiation were also less resistant to UV. Cultures of vegetative cells of B. subtilis were found to contain variable proportions of spores, which renders meaningless the study of irradiation of vegetative cell cultures at high doses. At lower doses, the frequency of UV-induced mutants was higher in spores than in vegetative cells at comparable survival. These results are consistent with the view that the lethal and/or mutagenic UV injury in spores is of a different nature from that in vegetative cells (pyrimidine dimers). (auth)

32624 INACTIVATION AND MUTAGENESIS ON THE ISOLATED DNA. I. THEORY OF INACTIVATION OF TRANSFORMING DNA. Bresler, S. E.; Kalinin, V. L.; Perumov, D. A. (Inst. of High Molecular Compounds, Leningrad). Genetika, No. 5, 133-42(May 1967). (In Russian).

On the basis of general assumptions a phenomenological theory of inactivation of transforming DNA by different agents such as chemical mutagens, uv γ radiation and nucleases was developed. The theory contained one fundamental empirical parameter Z, the number of hits per unit of genetic length. All the deductions of the theory were corroborated by experiment. In the case of DNA damage by the action of pancreatic DNAase, the average number of hits per unit of weight was measured chemically and compared with the number Z found from the genetic experiments on the efficiency of transforming DNA. From this data the physical dimensions of the scale of the genetic map in Bacillus subtilis were calculated. The results were in agreement with other measurements of the genetic unit. (auth)

32625 GENETICAL AFTER-EFFECTS OF X RAYS DEPENDING ON THE TEMPERATURE REGIME. Tikhomirova, M. M.; Dzhimelin, A. A.; Belyatskaya, O. Ya. (Leningrad State Univ.). Genetika, No. 5, 95-104(May 1967). (In Russian).

It was shown by the study of the dependence of the after effect of x rays on the regime of the subsequent high temperature treat-

ment on chromosomes of Drosophila melanogaster that the after effect is proportional to the duration of exposure to high temperature within the interval between 30 minutes and 8 hours and 30 minutes after irradiation; each hour of exposure to high-temperature resulted in the actual occurrence of 0.24% of potential breaks. Without temperature treatment, however, the kinetics of repair of hard x ray-induced potential damages had an uneven character: most of them were repaired during the first 30 minutes after irradiation, but subsequently the rate of reparation slowed down. In case of soft x rays the aftereffect (120%) could be detected only when the temperature treatment was immediate, which suggests that all the potential breaks are repaired during an hour after irradiation without any subsequent temperature treatment. By the comparison of the effects of hard and soft x rays it was shown that they are equally effective so far as the total frequency of breaks is concerned. Both kinds of x rays differed only in the relative proportion of the types of breaks: hard x rays induced somewhat more potential breaks and less actual breaks as compared to soft x rays. (auth)

32626 EFFECT OF DIFFERENT TYPES OF IONIZING RADIATIONS ON THE INITIATION OF CHROMOSOME ABERRATIONS IN PEA. I. POSTRADIATION RECOVERY IN PEA. Akopyan, E. M. (Inst. of Medical Radiology, Obninsk, USSR). Genetika, No. 5, 45-51(May 1967). (In Russian).

Air-dried pea seeds (variety Capital, moisture content 17%) were irradiated with γ rays at doses ranging from 1.5 to 40 kR. at dose rates of 4200, 700, and 70 R/min; the highest dose applied at the lowest dose rate was 30 kR. The material was fixed at different moments during the first postirradiation mitosis. The proportion of damaged anaphases and the frequencies of fragments and bridges were scored. The time-effect curves were plotted to depict the dynamics of chromosome aberrations in the course of the cell cycle. The frequency of chromosomal aberrations decreased as fixation time postirradiation was increased. This decrease was assumed to be the result of spontaneous postirradiation recovery. No such decrease in the frequency of aberrations was observed at doses of 20 kR or higher at dose-rates of 4200 and 700 kR min. (B.H.S.)

32627 STUDIES IN THE RADIATION GENETICS OF ARABIDOPSIS THALIANA (L.) HEYNH. II. SURVIVAL AND FERTILITY OF G_1 PLANTS AFTER γ IRRADIATION OF DORMANT SEEDS. Ivanov, V. I.; Sanina, A. V.; Timofeeva-Ressovskaya, H. A. (Inst. of Medical Radiology, Obninsk, USSR). Genetika, No. 5, 16-23(May 1967). (In Russian).

Air-dried dormant seeds of Arabidopsis were treated with 10 to 20 kR ^{60}Co γ radiation at a dose rate of 3.7 kR/min. A routine vial culture method was used for growing the plants. A considerable decrease in percent survival of the cotyledon leaves and rosette stages at doses ranging from 110 to 160 kR was noted. A relatively slight decrease in survival at the inflorescence formation and flowering stages was observed when lower doses were applied. No changes in percent germination at any dose within the entire range were detected. An increase in the proportion of completely and partially sterile plants and a decrease in the average number of seeds per plant were recorded at doses ranging from 10 to 160 kR. Plants from seeds irradiated at a dose greater than 160 kR did not survive. The analysis of variance revealed a significant non-linearity in all the fertility and survival curves; considerable variation in the manifestation of most characters affected by the irradiation was also noted. On the basis of the fertility and survival data, a dose range of 100 to 120 kR appeared to be most effective for induction of mutations in Arabidopsis by means of dormant seed irradiation. (auth)

32628 THE BIOSYNTHESIS OF ACYCLIC CAROTENOIDS IN A MUTANT OF RHODOTORULA MUCILAGINOSA. Nusbaum-Cassuto, Era; Villoutreix, Jean; Malenge, Jean-Pierre (Faculte de Pharmacie, Nancy, CNRS, Nancy). Biochim. Biophys. Acta, 136: 459-72(Apr. 25, 1967). (In French).

A mutant of Rhodotorula mucilaginosa that was obtained by ultraviolet radiation and that has remained stable for several years was used to investigate the biosynthesis of acyclic carotenoids. With this mutant, 2-hydroxybiphenyl inhibited pigmentation that was accompanied by the accumulation of phytoene. After elimination of the inhibitor and in the absence of any exogenous carbon or nitrogen source, the cells colored rapidly. The evaluation of each carotenoid was followed as a function of time; results obtained allowed for exclusion of the hypothesis of independent formation of carotenoids and provided conclusive proof for the role of phytoene as a precursor of acyclic carotenoids. (B.H.S.)

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Refer also to abstracts 32312, 32313, 32344–32346, 32591, 32693, and 33191.

32629 (ANS-SD-4, pp 11-17) CRITERIA FOR RADIATION PROTECTION: PERMISSIBLE DOSE TO CRITICAL ORGANS. Rossi, Harald H. (Columbia Univ., New York. Radiological Research Lab.).

The major factors which determine the biological effects of radiation are: dose magnitude, dose rate, radiation quality, volume irradiated, organ sensitivity, individual variability, and age. In general the degree of effect depends on the magnitude of these factors in a complex way. Some of the effects which are of particular importance to radiation protection are: leukemia and other cancers, aplastic anemia, cataract, aging, and genetic anomalies. Because of the complex interaction of the variables, extensive simplifications in the formulation of standards are necessary. The most important biophysical question in the formulation of protection standards concerns the existence of a threshold for radiation injury. There are certain indications that there should be no threshold for late effects due to chronic irradiation and it is altogether prudent to assume that risk is proportional to dose. Equal absorbed doses of various radiations can lead to different levels of effect, and it is consequently necessary to apply a weighting factor, known as a quality factor (QF), which allows for this difference. The quality factor is related to the linear energy transfer (LET) and in essence is equal to the $-dE/dx$ of the charged particles. Its values are also selected conservatively for the most extreme case of low doses and dose rates in organ systems showing the largest quality effects. The product of the quality factor and the absorbed dose is the dose equivalent and its unit is the Rem. Thus the term maximum permissible dose is, more precisely speaking, the maximum permissible dose equivalent. Basic limits for occupational and non-occupational radiation exposure, based on basic principles of radiation protection, set forth in NBS Handbook 59, are presented. (C.H.)

32630 (ANS-SD-4, pp 25-45) DISTRIBUTION OF DOSE AND DOSE EQUIVALENT IN AN ANTHROPOMORPHIC PHANTOM RESULTING FROM BROAD-BEAM SOURCES OF MONOENERGETIC NEUTRONS. Snyder, W. J.; Auxier, J. A.; Brown, M. D.; Jones, T. D.; Boughner, R. T. (Oak Ridge National Lab., Tenn.).

One aspect of a large program at ORNL to determine energy deposition in phantoms is discussed. It is pointed out that any interpretation of neutron dose in terms of biological effects probably will need to take into account not merely a single value (for example, the maximum or midline dose) but will more likely need to consider the general pattern of dose in the body. A Monte Carlo computer code was developed that makes use of general geometry routines, a cross-section library developed at ORNL, and data compiled by the authors. Dose distributions as functions of LET and position were calculated in great detail. (C.H.)

32631 (ANS-SD-4, pp 47-8) TISSUE CURRENT-TO-DOSE CONVERSION FACTORS FOR NEUTRONS WITH ENERGIES FROM 0.5 TO 60 MeV. Irving, D. C.; Alsmiller, R. G. Jr.; Moran, H. S. (Oak Ridge National Lab., Tenn.).

To assist in the evaluation of the hazard associated with exposure to high-energy neutrons, a Monte Carlo computer program was used to calculate the energy deposition as a function of depth in a 30-cm-thick infinite slab of tissue resulting from neutrons incident on the slab at energies up to 60 MeV. The program treated nonelastic and elastic interactions, including evaporation processes and nuclear recoils. Cases of both normal and isotropic incidence were calculated for neutrons of 0.5, 2, 10, 18, 30, and 60 MeV. From these data, current-to-dose conversion factors were extracted for the average whole-body dose, the dose at a 5-cm depth, and the maximum dose. A set of quality factors (QF's) was adopted for transforming absorbed dose to dose equivalent. Although normalized to incident current, the results can be used with a known incident flux density by applying normalizing factors. (C.H.)

32632 (ANS-SD-4, pp 49-56) ON DEPTH-DOSE CALCULATIONS IN AN EVALUATION OF FALLOUT SIMULATORS AND FALLOUT FIELDS. Garrett, C. W. (Armed Forces Radiobiology Research Inst., Bethesda, Md.); French, R. L. (Radiation Research Associates, Inc., Forth Worth, Tex.).

Calculations were made of the radiation depth dose resulting from fallout. Measurements were made at specified detector points in typical geometries for simulated fallout fields. The photon angle and energy distribution at each detector point were considered. A detector was also located at the axial midpoint in a foxhole placed in the fallout field. Cobalt-60 sources and a three-isotope disc source (^{60}Co, ^{137}Cs, plus ^{144}Ce) were used to simulate fallout fields and axial and depth-dose distributions in homogeneous, tissue-equivalent cylindrical phantoms were made from data obtained from detectors placed at the phantom midpoint. The COHORT Monte Carlo computer program was used to calculate the radiation doses. (C.H.)

32633 (ANS-SD-4, pp 57-65) A NEW TECHNIQUE FOR THE COMPUTER REPRESENTATION OF THE HUMAN BODY. Mittelman, Phillip S.; Guber, Walter (Mathematical Applications Group, Inc., White Plains, N. Y.).

A detailed three dimensional computer model of the human body was developed that is based on simplified geometrical input and requires a minimum computer memory. Each of the body organs can be described and located in its proper position in the model. Scale changes are also easily made to allow its use for interspecies comparisons. The use of this geometrical body description technique in association with the UNC-SAM II Monte Carlo program will permit radiation dosage calculations to be made with a very high degree of accuracy. (C.H.)

32634 (ANS-SD-4, pp 67-78) PHYSICAL AND BIOLOGICAL DOSE CALCULATIONS FOR PROTON AND ALPHA FLUXES INCIDENT ON A SHIELDED MAN MODEL. Hill, C. W.; Simpson, K. M. Jr.; Ritchie, W. B. (Lockheed-Georgia Co., Marietta).

Three types of man models, a sphere, two cylinders, and a reasonable facsimile of the human body, were used for computer calculations of the physical and biological dose for proton and α fluxes from solar flares incident on a shielded man. The radiation exposure arising from solar flux events during a 1986-1987 Mars space expedition was estimated with the aid of FLARE, a Monte Carlo computer code. The FLARE code uses data derived from observations of solar flux events during solar activity cycle 19. The probability of an event is sampled for each day of the mission, and proton and α flux spectra are accumulated over each mission history. Each mission is represented a large number of times on the computer. A number of codes are available to treat proton transport problems in simple geometries but no α transport code that treats secondaries in detail is available. The DOSE code, used in this study, attempts to include an estimate of α-induced secondaries and is based upon ratios of α and proton from radiochemical data. A point kernel method was employed for the treatment of charged particle transport. Physical dose was calculated in a standard way using the charged particle stopping power and a dose buildup factor derived from a detailed transport code provided for dose due to secondaries. Biological dose, nominally in Rem, was obtained with the quality factors recommended by the ICRP. Results showed that spherical man models can safely be used to estimate radiation dose to skin, eyes, midline, and possibly hematopoietic system in parametric studies with fairly uniform shields. (C.H.)

32635 (BNWL-SA-1220) MEASUREMENT OF PLUTONIUM AEROSOL PARAMETERS FOR APPLICATION TO RESPIRATORY TRACT MODELS. Andersen, B. V.; Nelson, I. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1966]. Contract AT(45-1)-1830. 26p. (SM-94-48; CONF-670704-5). Dep. CFSTI.

From IAEA Symposium on Instruments and Techniques for the Assessment of Airborne Radioactivity in Nuclear Operations, Vienna, Austria.

The concentration and particle size distribution of plutonium aerosols as measured in employee work areas are important parameters in the analysis of chronic internal exposure received by radiation workers. Measurement results are presented from a study of a variety of exposure situations in three major plutonium handling facilities. Plutonium-239 aerosol concentration measurements ranged from near worldwide fallout values of about 0.5 f Ci/m^3 to several thousand f Ci/m^3. The particle size distributions were found to be bimodal in nature. Treatment on a bimodal basis permitted inclusion of large particles, which were found to be present in nearly all samples examined. The typical aerosol showed an activity median diameter (AMD) of about 0.2 micron with a geometric standard deviation of 1.4 for sixty percent of the plutonium-239, and forty percent exhibiting an AMD of 2.4 microns with a geometric standard deviation of 1.3. The concentration and particle size distribution data were then utilized in the study of relationships of chronic inhalation with current respiratory tract models for deposition and retention of plutonium aerosols. Pulmonary burdens of plutonium-239 for chronic exposures were calculated to be in the piccocurie to nanocurie range. Relationships of particulates to other organ doses, bioassay, and autopsy data are also presented. (auth)

32636 (CONF-661018, pp 24-35) URANIUM LEVELS IN HUMAN DIET AND BIOLOGICAL MATERIALS. Welford, George A.; Baird, Ruth (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

There has been increasing interest in accurately documenting the levels of natural radioisotopes in man, his diet, and environment. The tri-city diet program, for the study of strontium-90 levels, presents an opportunity to measure the uranium content of foods, as monthly total diet samples are available from New York City, Chicago, and San Francisco. In addition to the diet, materials such as air, bone, lung, and water samples were analyzed from the New York area. The data indicate uniform intake of uranium at the three sites examined. The values found were 1.3, 1.4, and 1.3 micrograms of uranium per day for New York City, Chicago, and San Francisco, respectively. The urinary excretion levels for non-exposed individuals are reviewed and new data from the Chicago area indicate a range of values within the previously reported New York data of from 0.03 to 0.3 microgram of uranium per liter. (auth)

32637 (CONF-661018, pp 36-52) UPTAKE OF RADIOACTIVITY BY VEGETATION: A FOLLOW-UP STUDY. Gabay, J. J.; Dapolito, J. A.; Daly, J. C.; Sax, N. I. (New York State Dept. of Health, Albany).

To further evaluate the effect of time on the uptake of radioactivity due to soil contamination, a follow-up study was initiated. The same sub-plots were used. No additional radionuclides were added to the soil- and foliar-contaminated plots used the year before. In the follow-up study only corn, lettuce and tomatoes were planted. Lettuce and tomatoes were processed and analyzed as before; corn yielded four fractions: cobs, husks, kernels, and stalks. Corn stalks were analyzed in the study to evaluate their uptake since stalks as well as the ears were used as cattle fodder. In addition, a small section of each of the control plots (40′ × 52′) was roped off and before planting spiked with 0.5 mCi each of ^{65}Zn, ^{137}Cs, ^{54}Mn, and ^{106}RuRh. The first three nuclides were used to confirm and further study the predominant species appearing in soil-contaminated crops in the first study; ^{106}RuRh, to further elucidate the 0.51 MeV region. The same crops were planted in these sub-plots as in the others. In general, the results followed the anticipated pattern. Levels of activity in the crops, due to uptake, decreased with time; crops from the previously foliar-contaminated plots showed a significantly greater decrease. Again, crops grown on the non-fertile plots showed greater uptake than those grown on the fertile plots. However, several interesting deviations from the expected patterns were noted throughout the experiment. (auth)

32638 (CONF-661018, pp 61-73) PRECIS OF THE PROPOSED LUNG MODEL. Morrow, Paul E. (Rochester Univ., N. Y.).

In relation to the information available on air sampling techniques and instrumentation, dust deposition and clearance, and radioactive hazard evaluation, the lung model currently used by the ICRP to estimate radiation dose from inhaled radioisotopes was evaluated. Other factors taken into consideration were clearly described in terms of the different regions of the respiratory tract and the major redistribution pathways and mechanisms; the physical-chemical properties of dust; and the variable nature of respiratory performance under different work loads. A description of the new model and the improvements that were made as determined by the evaluation study are presented. (B.H.S.)

32639 (CONF-661018, pp 74-86) USE OF THE LUNG MODEL FOR ESTIMATION OF DOSE. Snyder, W. S. (Oak Ridge National Lab., Tenn.).

Using the lung model developed by the ICRP Task Group on Lung Dynamics, the μCi-days of residence of inhaled radioactive aerosols in three regions or compartments of the respiratory tract: the nasopharynx (N-P), the trachea and bronchial tree (T-B), and the pulmonary compartment (P) were estimated. The report also provided an estimate of deposition and retention in the lymph of the respiratory system (L). Formulas for the μCi-days of residence in each compartment were developed in terms of the parameters used in the report to define the model and to characterize the aerosol. The dosimetric problems involved are discussed and formulas developed for expressing the dose to each of the compartments and to the lung as a whole. Adjustment factors were given to take account of the activity median aerodynamic diameter of the aerosol. For alpha emitters and beta rays of short range (less than 20 μ) the dose to the N-P and T-B regions was computed by considering the radioactive material as a surface deposit. For photons and beta rays of greater range, much of the energy was absorbed outside the region of deposition, and the dose estimate was an average for the lung as a whole. Following years of continuous exposure, the lymph of the respiratory system can contain a significant fraction of the total lung burden according to the present lung model. Thus the model did predict high concentrations and doses in lymphatic tissue as has been observed experimentally and as a result of human exposures. (auth)

32640 (CONF-661018, pp 87-97) AIR SAMPLING PROBLEMS ASSOCIATED WITH THE PROPOSED LUNG MODEL. Mercer, T. T. (Rochester Univ., N. Y.).

Air sampling requirements introduced by the new lung deposition model proposed by the Task Group on Lung Dynamics are considered in relation to available sampling techniques. It was shown

that present techniques for determining the activity median aerodynamic diameters of hazardous dusts are sometimes not applicable in practice. The alternative technique offered by size selective samplers is discussed and recommendations are made for relating respirable dust concentrations to the new lung model. Certain limitations of the deposition model are briefly discussed. (auth)

32641 (CONF-661018, pp 117-19) UPTAKE OF ^{125}I IN THYROID OF SEVEN INDIVIDUALS FOLLOWING INHALATION INCIDENT. Bordell, F. L.; Sayeg, J. A.; Wald, N. (Pittsburgh Univ., Pa. Dept. of Occupational Health); Wechsler, R. L. (Pittsburgh Univ., Pa. School of Medicine).

Seven persons were accidentally exposed to ^{125}I vapors. Initial thyroidal uptakes and dose values were determined. A least-square analysis of the biodecay data was performed and the estimated half-life for ^{125}I was found to be 38 to 45 days with an average of 41 ± 2 days. Neglecting the initial rapid drop off between days 0 to 4, internal dosimetry calculations based on these uptakes and under the assumption of a unit density, 20 gram thyroid gland, gave dose values of 1.1 to 114 rads. (B.H.S.)

32642 (CONF-661018, pp 120-33) DETECTION OF INSOLUBLE ALPHA EMITTERS IN THE LUNG. Caldwell, Roger (Nuclear Materials and Equipment Corp., Apollo, Pa.).

Data illustrating that fecal sampling is the only satisfactory method for estimating lung burdens of insoluble alpha emitters are presented. The insoluble alpha emitters considered were ^{241}Am, ^{239}Pu, ^{232}Th, and ^{234}U. Other methods considered were urinalysis and in vivo counting. (B.H.S.)

32643 (CONF-661018, pp 134-45) EVALUATION OF THE PUQFUA METHOD OF CALCULATING BODY BURDENS. Wood, William R. Jr.; Sheehan, Warren E. (Mound Lab., Miamisburg, Ohio).

Data on urinary excretion of ^{238}Pu following pulmonary deposition were obtained from five cases of depositions from plutonium dioxide and from one case of deposition from a mixture of more soluble compounds of plutonium. The PUQFUA system was used to estimate body burdens for these cases. An evaluation of the calculated body burdens for various time periods after exposure showed an exponential movement of plutonium from the lungs to the systemic circulation. The average half-time for the five cases was estimated to be 240 days, while the half-time for the exposure from more soluble compounds was 29 days. Through the use of the 240-day half-time, body burden estimates were made by an integration method and by a lung urinary excretion curve method. Values agreed with the PUQFUA calculated body burdens and justified the use of the PUQFUA system in calculating body burdens received by transfer from the lungs to the systemic circulations. (auth)

32644 (CONF-661018, pp 174-90) AGE-DEPENDENT MODEL FOR THE BODILY RETENTION OF CESIUM. Fisher, H. L. Jr.; Snyder, W. S. (Oak Ridge National Lab., Tenn.).

After an intake of cesium, the element is eliminated over a period of time. It was found that a one- or two-exponential retention function was usually sufficient to fit the observed data; this retention model was valid for adults and children, but the elimination rates were different in each case. A mathematical compartment model is proposed that allows compartment size or growth to be included naturally. The model is applied to the retention of cesium-137 by humans from birth through adult life. The biological half-times predicted with the model were compared to experimental values with favorable results although there was still much variation of the observed half-times within an age group. The implications of the model in regard to dose from single and continuous intakes are examined. (auth)

32645 (HW-67164) RADIATION ASPECTS OF THE REDOX MULTIPURPOSE DISSOLVER INCIDENT. Uebelacker, D. L. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Oct. 25, 1960. Contract AT(45-1)-1350. 30p. DTIE.

A Redox multipurpose dissolver incident that occurred on March 17, 1960, is described. Some of the U metal ignited and the reaction generated sufficient pressure to blow off the gravity fit dissolver lid. Subsequent examination showed holes in the dissolver shell. Contamination was spread during the original dissolver reaction, during another dissolver reaction approximately 24 hr later, and during entry into B cell. Results are reported from measurements of radioactivity at various locations, and methods used to control contamination and for decontamination of the canyon and crane are described. (C.H.)

32646 (JAERI-4040) BIOLOGICAL DOSIMETRY AT THE TIME OF A RADIATION EXPOSURE. Kobayashi, Hiroo; Kobayashi, Yukichi; Ohira, Ichiro (Japan Atomic Energy Research Inst., Tokyo). Sept. 1966. 16p. (In Japanese and English). Dep.

Biological dosimetry has the advantage that exposure doses can be estimated at a radiation accident, even when personnel do not wear physical dosimeters such as film badges. The literature on the blood cells, emzymes of blood, and chromosomes was reviewed for the evaluation of various methods. It was concluded that the counting of the number of various cells like lymphocytes and thrombocytes and the measurement of leucocyte alkaline phosphatase and BAIBA in urine are useful for the determination of radiation doses. The changes of myelogram and chromosomes and the amounts of ^{24}Na in the blood are also good indices for dose level determinations. (auth)

32647 (NP-16518) POSTUPLENIE PRODUKTOV ISPYTANII YADERNOGO ORUZHIYA NASELENIYU SOVETSKOGO SOYUZA S PISHCHEVYM RATSIONOM I VODOI V 1963-1964 GG. (USSR Population Dietery Intake of Food and Water Contaminated by Nuclear Tests Fallout During 1963-64). Knizhnikov, V. A.; Stepanov, Yu. S.; Petukhova, E. V.; Barkhudarov, R. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1965. 22p. (In Russian). Dep.

The contents of ^{90}Sr and ^{137}Cs in basic food products of the USSR in 1963 and 1964 were the same and occurred at the same levels as in other countries of the northern hemisphere. Some increase in the level of contamination in grain and potato crops took place in 1963 in comparison with the crops of 1962. In contrast to the western countries where the basic source of radioisotopes to the population was in dairy products, almost 75% of the ^{90}Sr and almost 50% of the ^{137}Cs was in bread products. The intake of ^{90}Sr from the daily diet by urban populations amounted to almost 40 Ci in 1963 and 60 Ci in 1964; the values for ^{137}Cs were 212 and 294 Ci, respectively. The intake of radioisotopes in rural populations was very different and was believed to be associated with national peculiarities of the diet structure. (tr-auth)

32648 (NP-16523) O POSTUPLENII STRONTSIYA-90 V RASTENIYA. (Uptake of ^{90}Sr by Plants). Pavlotskaya, F. I.; Tyuryukanova, E. B.; Babicheva, E. V.; Baranov, V. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1965. 24p. (In Russian). Dep.

The degree of uptake of ^{90}Sr, stable Sr, and Ca in plants depends on the physical-chemical properties of the soil (pH, humus concentration, exchangeable Ca, and mechanical state), the form of the elements in the soil, species characteristics of the plant, agricultural engineering, and climatic conditions. The concentration of ^{90}Sr in the plant depends also on the level of radioactive fallout, the development of the plant, and the forms and sizes of the surface of the aboveground parts. For plants grown in natural conditions, there is no correlation between the ^{90}Sr concentration in the plants and the concentration of this isotope in the soil. There is also no correlation with the free calcium in the soil. Accumulation in the plants of radioactive Sr, stable Sr, and Ca is 0.004 to 3.2, 0.0005 to 0.08, and 0.006 to 0.26%, respectively, in dependence on the species characteristics of the plants and the type of soil. Because of the simultaneous effect of a great number of diverse factors on the uptake of radioactive Sr in plants it is not always possible to transfer quantitatively the regularities observed in model tests to natural conditions. (tr-auth)

32649 (NP-16751) INSTALLATION AND FUNCTIONING OF A LABORATORY FOR THE DETECTION AND IDENTIFICATION OF THE RADIOACTIVITY IN THE BIOSPHERE. Danali, Susan D. ("Democritus" Nuclear Research Center, Athens (Greece)). 1966. 71p. (In Greek). Dep.

A detailed proposal made for the organization and operation of a laboratory for the detection and identification of the radioactive contamination of the biosphere is presented. The existence of such a laboratory is to show the sources of radioactive contamination of the environment and man, and to point out the ways of checking the radioactive contamination of the biosphere; to emphasize that certain prerequisites are necessary for successful checking of this kind and to discuss ways of meeting them for the best possible operation of the laboratory; and to define the different activities of the laboratory according to which the laboratory is divided into sections, to describe in detail the work of each section, to give the correct operational interdependence of the sections, and also a complete organization chart. Laboratory furniture and equipment, including equipment in the open air and also the essential features of the basic counting equipment, including its method of operation and correct use, are described. Personnel needs of the laboratory, necessary space and its arrangement, and rules for the satisfactory operation of the laboratory are discussed. Use of the laboratory for meeting the needs of Greece in this field is examined. In this respect a program of work thought necessary is given in tables and financial estimates are made for constructing, equipping and staffing of such a laboratory. (auth)

32650 (NP-16802) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 5, Number 3. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Mar. 1967. 58p. Dep.

Data are presented on the content of ^{90}Sr in samples of bones from subjects who died during 1964, 1965, and 1966; total β activity due to fallout in samples of air and precipitation, and the content of ^{137}Cs and ^{90}Sr in samples of precipitation and liquid milk collected in Feb. 1967; and radioactivity in the environs of Canadian reactors during Feb. 1967. (C.H.)

32651 (ORNL-P-3081) COMPARATIVE MOVEMENT OF ^{106}Ru, ^{60}Co, AND ^{137}Cs IN ARTHROPOD FOOD CHAINS. Crossley, D. A. Jr. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 24p. (CONF-670503-14). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

The behavior of radiocesium in food chains has been relatively well documented in results of environmental studies and tracer experiments, but little information is available on food chain behavior of ^{106}Ru. New data from a waste disposal site (White Oak Lake bed) permit comparison of ^{106}Ru and ^{60}Co with the distribution of ^{137}Cs along a terrestrial food chain consisting of soil, herbaceous vegetation, herbivorous arthropods, and predaceous arthropods. Vegetation accumulated ruthenium and cobalt more efficiently than cesium (concentration factors of 0.06 vs 0.02). Herbivores also accumulated relatively more ^{106}Ru and ^{60}Co than ^{137}Cs. Predaceous arthropods had ^{106}Ru concentrations approximately twice those of herbivores, although ^{137}Cs and ^{60}Co concentrations in herbivores and predators were similar. These distributions indicate that ^{106}Ru has a greater food chain mobility than does ^{137}Cs and ^{60}Co, with an increase in concentration of ^{106}Ru in herbivore to predator transfers. Turnover rates (biological half lives) for ^{106}Ru and ^{60}Co were compared with ^{134}Cs turnover rate in one insect species (Acheta domesticus L.), and results are reasonably consistent with the data obtained from White Oak Lake bed. (auth)

32652 (ORNL-P-3084) CESIUM, ^{137}Cs, AND POTASSIUM CONCENTRATIONS IN WHITE CRAPPIE AND OTHER CLINCH RIVER FISH. Nelson, D. J. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 21p. (CONF-670503-13). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

Potassium concentrations in white crappie were relatively constant throughout the year and the average of all specimens was 3.48 mg/g fresh weight. Other species, including drum, white bass, channel catfish, and bluegill, contained similar K concentrations, and the K content of fish was considered a conservative property. Cesium concentrations in the white crappie flesh were about 0.8×10^{-2} μg/g fresh wt from May through July, and during the remainder of the year varied from 1.0×10^{-2} to 1.6×10^{-2} μg/g. In addition to varying seasonally, the Cs content of different species ranged from 0.344×10^{-2} μg/g in bluegill to 1.60×10^{-2} in white bass. Concentration factors for K were from 2500 to 2700, while those for Cs were from 140 to 640. The average specific activity of ^{137}Cs in white crappie flesh was about the same as the average specific activity in Clinch River water. These results showed that specific activities of ^{137}Cs may be used to predict ^{137}Cs concentrations in fish for chronic releases of ^{137}Cs to surface streams. The variable Cs content and the constant K content of fish vitiates application of ^{137}Cs to K ratios for predictive purposes. (auth)

32653 (ORO-490-3) RADIOACTIVITY TRANSPORT IN WATER: TRANSPORT OF ^{51}Cr IN AN AQUEOUS ENVIRONMENT. Technical Report 11. Canter, Larry W.; Gloyna, Earnest F. (Texas Univ., Austin. Environmental Health Engineering Research Lab.). May 1967. Contract AT(11-1)-490. 264p. (EHE-04-6701; CRWR-17). Dep. CFSTI.

The transport of both trivalent ^{51}Cr and hexavalent ^{51}Cr in an aqueous environment was studied. Trivalent ^{51}Cr existed in a cationic form and $^{51}Cr(VI)$ existed in an anionic form. Measurements were made of the distribution of $^{51}Cr(III)$ and $^{51}Cr(VI)$ among the sediment, solution, rooted plants (Vallisneria), and suspended material in aquaria and a model river under both non-polluted and inorganic (clay) polluted conditions. (C.H.)

32654 (SC-DC-67-1844) RADIOACTIVE ENVIRONMENTAL SURVEY AT SANDIA CORPORATION. Brewer, L. W. (Sandia Corp., Albuquerque, N. Mex.). June 1967. Contract AT(29-1)-789. 7p. (CONF-670614-1). Dep. CFSTI.

From Annual Meeting, Confederation of Western Affiliates, American Public Health Association, Albuquerque, N. Mex.

The methods used for collection, analyses, and evaluation of soil, vegetation, and water samples from the local environment surrounding Sandia Corporation (Area V), the City of Albuquerque, and Bernalillo and Sandoval Counties, New Mexico, are described. Samples were analyzed for ^{137}Cs, ^{90}Sr, ^{90}Y, and gross beta activities. Other isotopes such as barium-140 and uranium-238 were occasionally examined. (B.H.S.)

32655 (UCLA-12-628) AIR-BORNE RADIOACTIVITY IN FALLOUT AREAS. Romney, E. M.; Mork, H. M. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Apr. 1967. Contract AT-04-1-GEN-12. 16p. Dep. CFSTI.

Summaries of findings on air-borne radioactivity in fallout areas that were observed during previous studies of fallout from nuclear detonations at the Nevada Test Site are presented. (auth)

32656 (UCRL-17283) ENERGY-LOSS DISTRIBUTIONS AND FRACTIONAL CELL LETHALITY. Curtis, Stanley B. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 18, 1966. Contract W-7405-eng-48. 27p. (CONF-661001-46). Dep. CFSTI.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

In the evaluation of the hazard from a given radiation environment, various factors other than the absorbed dose play an important role in determining the biological response. One of these is the quality of the radiation, that is, the dE/dx of the particles depositing the dose. It is convenient, especially when dealing with charged particles heavier than electrons, to display the dose at a point as a function of dE/dx. This function is called an energy-loss or dE/dx distribution. Such a representation allows an evaluation of the importance of the various dE/dx components that comprise the dose. In particular, the high dE/dx components are of interest because it has been shown that, in general, high dE/dx radiation is more effective, that is, has a higher RBE (Relative Biological Effectiveness) in producing biological damage than low dE/dx radiation. Examples are given of dE/dx distributions due to two typical solar-particle events in free space with different spectral shapes and under different shielding thicknesses. The case of a steep spectrum under thick shielding shows the proton component dominating, while the case of a flatter spectrum under thin shielding shows the helium-ion component to be slightly more important than the proton component. Methods are described for calculations of the radiation dose to astronauts from a solar event that are based on the ratio of inactivation hits/cell of the heavy components to that of the protons. The fractional number of cells inactivated or fractional cell lethality (FCL) can be calculated if the numbers of lethal hits/cell are known from both the reversible and irreversible damage mechanisms. It turns out that irreversible damage dominates for the solar events chosen for illustration. FCL values were calculated for two points inside the body at the waist of a seated astronaut for several large solar-particle events of the last solar cycle, taking into account the body self-shielding. The results show that up to 7% of the cells would have been inactivated 4 cm inside the body at the waist behind 1 g/cm^2 of vehicular shielding in the largest event. Such calculations as these may help in the future for the evaluation of the hazard from mixed-heavy-particle radiation environments when inactivation cross sections or other suitable "malfunction" cross sections are available for more critical and perhaps irreplaceable cells in the body and when accumulated damage over a long period, such as for extended space flight, is of importance. (C.H.)

32657 (UCRL-17412) ACCURACY OF VERY-HIGH-ENERGY RADIATION MONITORING. Patterson, H. Wade (California Univ., Berkeley. Lawrence Radiation Lab.). May 1967. Contract W-7405-eng-48. 11p. (CONF-670621-2). Dep. CFSTI.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation and Required Accuracy in Radiological Protection, Stockholm, Sweden.

In order to ensure suitable accuracy in health physics measurements of very-high-energy radiation, it is first necessary to lay a proper foundation of knowledge and understanding of the radiation field. This should be done by choosing detectors and analyzing systems that are selective in their response to the radiation of interest and with satisfactory sensitivity. In complex radiation fields, such as those produced by particle accelerators, it is necessary to use several detectors, each with its own range of response and sensitivity. For example, to evaluate the radiation field produced by a proton accelerator of more than 500-MeV energy the neutron energy spectrum must be measured with a series of different detectors whose energy threshold and response as a function of energy are well known. Statistical accuracy in these measurements is based on reducing background in the detection system and controlling its fluctuations. In addition, sensitivity should be such that count rates and signal-to-noise ratios are large. This usually means a large volume or mass of detector. Experimental accuracy is based on knowing the response of the detector as a function of energy,

both as regards selectivity and sensitivity. Experimental parameters and operating conditions of the accelerator should be varied, to check for reasonable variations in detector response. Proper monitors should be used so that data taken at different times can be normalized. Results from different detectors should be compared for consistency and compliance with physical principles. After the radiation field is described in physical terms, i.e., energy spectrum and intensity of each of the components, one can then proceed with some confidence to the use of detectors whose response is ambiguous (rad or rem meters), but which may be of practical use. Shielding for personnel and equipment can be accurately specified, and one can predict the effect of changes in operating conditions of the accelerator. This analytic approach to very-high-energy radiation monitoring requires time and effort, but these are repaid by the accuracy, flexibility, and understanding achieved. (auth)

32658 (UCRL-17573) EFFECTS OF ROUTINE OCCUPATIONAL RADIATION EXPOSURE IN WORKERS AT THE LAWRENCE RADIATION LABORATORY, BERKELEY. Barr, George Douglas (California Univ., Berkeley. Lawrence Radiation Lab.). May 1967. Contract W-7405-eng-48. 99p. Dep. CFSTI. Thesis.

The hypothesis that there are no physiological effects from routine occupational radiation exposure was tested in a group of 105 Lawrence Radiation Laboratory (Berkeley) employees. Routine in-plant medical examination results (emphasizing hematology) were compared over a ten-year period with accumulated radiation doses that were taken from film badge records. The range of individual ten-year accumulated radiation doses was 3 to 87 rems. The study hypothesis was not rejected for any medical examination procedure tested; i.e., there were no effects of radiation exposure shown in the investigation. (auth)

32659 (JPRS-39318) RADIOTOXICOLOGICAL ASPECTS OF RADIOACTIVE CONTAMINATION. Furnica, Gh.; Racoveanu, N. Translated from Igiena (Bucharest), 15: 577-87(1966). 13p. (TT-66-35740). CFSTI $3.00 cy, $0.65 mn.

Radiotoxicological aspects of the radioactive contamination process revealed the great importance of new studies on the toxicology of radioactive substances. The material presented does not treat exhaustively the field of interest of radiotoxicology but emphasizes the necessity of continued investigations in this area; systematic measurements must be carried out. The science of radiotoxicology must be directed towards two main goals: applied research aimed at the development of simple selective analytical methods sufficiently sensitive to detect radioactive contamination and for the periodic monitoring of the body burden; the materials which interfere with the analytical study of radionuclides in the mixture must also be studied. (auth)

32660 PROGRAM FOR CALCULATION OF DOSE DISTRIBUTION FOR PENDULUM IRRADIATION WITH A 42-MeV BETATRON. Persson, John-Erik; Rohleder, Karsten (Regionskrankenhauses, Oerebro, Sweden. Svenska Siemens Datasektion, Stockholm). Strahlentherapie, 133: 13-19(May 1967). (In German).

From depth dose data experimentally determined through ionization chamber measurements in water phantoms, formulas were developed for the central depth dose curve as well as for points outside this one. The deduced formulas were used in a program for calculation of dose distributions at pendulum irradiation with 40 MV x rays. (auth)

32661 ^{90}Sr IN TEETH. A PRELIMINARY REPORT ON THE COLLECTION OF TOOTH MATERIAL: CHEMICAL ANALYSIS OF THE MATERIAL AND SOME RESULTS OF MEASUREMENT. Lindemann, J. (Koebenhavns Tandlaegehoejskoles, Copenhagen). Tandlaegebladet, 69: 297-304(Apr. 1965). (In Danish).

An account is given of the collection of teeth, their chemical analysis, and some preliminary results on the ^{90}Sr activity of pooled deciduous canines and first and second deciduous molars. The deciduous teeth, collected in 12 communities throughout Denmark from children born during the years 1950 through 1957, were extracted in 1963. The crowns and roots were separated at the cemento-enamel junction and the ^{90}Sr activity was determined separately for crowns and roots. The method used involved milking and counting of the ^{90}Y daughter. An increasing amount of ^{90}Sr was found over the years 1950 to 1957 for crowns and roots. The highest amount (1.6 pCi ^{90}Sr/g Ca) was found in roots from children born in 1957. (BBB)

32662 RADIOACTIVE STRONTIUM AND MILK. Agr. Res. (U.S.), 12: 15(Aug. 1963).

A pilot plant process is described that can remove more than 90% of radiostrontium from milk. This process will be evaluated on a commercial scale by a Missouri dairy cooperative under a contract with the USDA and the Department of Health, Education, and Welfare. The Producers Creamery Company will determine the commercial feasibility of the process and work out details for its operation on an industrial scale at the company's plant in Lebanon, Mo. The process was developed at the Agricultural Research Center, Beltsville, Md., as a cooperative project with the U. S. Public Health Service and the U. S. Atomic Energy Commission. Work was begun 3 yr ago to develop the process for consideration in the event of nuclear emergency. The commercial evaluation will involve scaling up the operation from a rate of 850 lb of milk per hr to about 12,500 lb and determining its potential for use in the average dairy plant. The process consists of filtering slightly acidified milk through columns of resin charged with mineral salts similar in composition to salts in milk. Radiostrontium ions in the milk exchange with the mineral salts in the resin. The milk, freed of most of the radiostrontium, has its excess acidity neutralized and is then pasteurized and homogenized. (BBB)

32663 EMPIRICAL FACTORS FOR EVALUATING THE CONTAMINATION OF AGRICULTURAL PLANTS WITH RADIOACTIVE FISSION PRODUCTS TAKING INTO ACCOUNT THE WORLD-WIDE FALLOUT OF NUCLEAR TESTS. Reissig, H. (Technische Univ., Dresden). Kernenergie, 10: 131-7(Apr. 1967). (In German).

In previous studies the ^{90}Sr contamination of agricultural plants in the territory of the German Democratic Republic during the period from 1960 to 1963 was studied. From these and other data empirical factors for evaluating the ^{90}Sr contamination of the plants were calculated, including the average relationships between fallout intensity and surface contamination or ground contamination and uptake by the roots. In the same manner total fallout (fission product mixture) contamination factors of the plants were calculated from available data (unpublished). Using these empirical factors the future contamination of the agricultural plants may be calculated with sufficient accuracy when fallout intensity or ground contamination is known. (auth)

32664 EXPERIENCES IN THE CARRYING OUT OF THE RADIATION PROTECTION REGULATIONS. Minder, W. Radiol. Clin. Biol., 35: 323-31(1966). (In German).

Three years since the enactment of the radiation protection regulations governing medical facilities in Switzerland a preliminary survey on the results of the plant and personnel controls is given. Whereas in older installation, deficiencies in radiation protection practices both for diagnostics and for therapy must be corrected in almost all cases, the construction of new installation completely or almost completely satisfies all requirements. The exposures of professionally exposed personnel are, in most cases, significantly under the maximum permissible doses. (tr-auth)

32665 USE OF HELICOPTERS FOR THE MEASUREMENT OF TERRAIN CONTAMINATION. Gut, J. Radiol. Clin. Biol., 35: 387-90(1966). (In German).

The use of suitably equipped helicopters was proposed in order to obtain as quickly as possible a picture of the extent and intensity of the contaminated area following the deposition of radioactive fission products after a nuclear explosion or reactor accident. Since with increasing height over the terrain, the radiation intensity decreases, the accumulated dose of the crew can be kept small by adjustment of the flight height. Extensive areas can be measured radiologically in a short time. The communication system installed permits the immediate information on injured troops or populations. (tr-auth)

32666 LARGE-SCALE FIXED-BED ION-EXCHANGE SYSTEM FOR REMOVING ^{90}Sr FROM FLUID MILK. II. COMPOSITIONAL STUDIES. Heinemann, B. (Producers Creamery Co., Springfield, Mo.); Baldi, E. J.; Marshall, R. O.; Sparling, E. M.; Walter, H. E.; Fooks, Jack H. J. Dairy Sci., 50: 426-30(Mar. 1967).

Pilot scale results have indicated that the fixed-bed ion-exchange system could substantially reduce the level of ^{90}Sr in milk. Investigations were, therefore, made to determine the commercial feasibility and practicality of the Beltsville pilot plant process for removing radionuclides from milk. Nine runs of 45,400 l of milk per 8-hr day were made, resulting in an average of 91.7% removal of environmental levels of ^{90}Sr. No significant increase in microbial population occurred during the runs, and the keeping quality of the processed milk appeared to be satisfactory. Flavor scores averaged 37.2 after processing, a decrease of 0.6 from the untreated samples. Minor compositional changes were found in measurements of freezing point, curd tension, titratable acidity, and ash. There was an increase of 0.36% in concentration of potassium citrate, due to acidification and neutralization of the milk. The remaining components tested showed insignificant changes. (BBB)

32667 AUXILIARY APPARATUS FOR TELECOBALT THERAPY. Holsten, D. R. (Medizinische Hochschule, Hanover). Roentgen Bl., 18: 127-34(Mar. 1965). (In German).

During conventional irradiation the lens of the eye can be protected adequately by means of Pb shields. When using the Gammatron a Pb cylinder 50 mm long can be used to protect the lens of the eye. With a dia of 10 mm for the lens, a 25-mm dia shield should be sufficient for protection. However, protection should also be afforded for the cornea, iris, and ciliary body. According to measurements at the center of the field and in the penumbral area of the field, the primary irradiation is reduced to 8 or 10% by the Pb cylinder. It has been reported that the dose from ^{60}Co γ irradiation can be reduced to 10% by means of a Pb cylinder 80 mm high and only 12 mm in dia. If then the lens of the eye is located in the vicinity of the irradiation field or in the penumbral area, as it is during therapy of mandibular tumors or brain tumors located in the frontal lobes, it should be protected with a Pb cylinder. Outside the penumbra from 1 to 2% of the primary radiation is still measurable when the Pb shielding is used, but without a shield 10 or 12% is found outside of the penumbra and 38% in the penumbra. For these reasons, even though the male gonads are located outside the direct radiation beam when the lower abdomen or extremities are irradiated, they should be shielded from strong radiations with 4 or 5 cm thick Pb blocks. (BBB)

32668 EXPOSURE TO X RAYS IN THE RADIODIAGNOSTIC DEPARTMENTS, BASED ON THE TEST FILM EVALUATION IN 1964. Baltrukiewicz, Zenon. Pol. Przegl. Radiol. Med. Nuklearnej, 31: 315-19(Mar.-Apr. 1967). (In Polish).

The results of individual dose measurements in diagnostic radiologic units are discussed. It was demonstrated that professional exposure to x rays in 1964 did not exceed the permissible annual doses; however, periodic permissible doses were exceeded in some units. (tr-auth)

32669 SEDIMENTOLOGICAL INTERPRETATION OF THE NATURAL RADIOACTIVITY OF THE BEACHES OF THE ATLANTIC COAST. Riviere, Andre; Vernhet, Solange (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. D, 264: 2184-7(May 3, 1967). (In French).

The sedimentological independence of the ligerian and garonnian regions was confirmed. The sedimentological influence of the Vendeen Massif and that of an ancient Seudre on natural radioactivity in the Atlantic Ocean are shown. (tr-auth)

32670 MICROWAVE OVEN RADIATION HAZARDS IN FOOD-VENDING ESTABLISHMENTS. Suroviec, Henry J. (Pennsylvania Dept. of Health, Meadville). Arch. Environ. Health, 14: 469-72 (Mar 1967).

Prevention of radiation leakage from microwave ovens is described. Of the units monitored 71% released radiation in excess of 1 milliwatt/sq cm, and 16% released radiation levels of 10 milliwatts/sq cm or above. The radiation intensities released appeared to depend on the construction design of the doors, with sliding doors providing the best seal to limit leakage. Although the radiation intensities found are not related to exposure time, the findings indicate that exposures in excess of 10 milliwatts/sq cm could exist. Measures to minimize the possibility of overexposure include: (1) The construction of ovens should utilize design features which prevent the release of microwave radiation; (2) interlock systems should be designed to prevent circumvention of their use; (3) units should be adequately labeled to alert owners and operators of the potential hazard of operating units in a manner other than the prescribed procedure; (4) owners, operators, and service personnel should be made aware of the hazard of exposure to microwave radiation; (5) units should be monitored periodically to detect leakage or faulty operational devices. (auth)

32671 EFFICIENCY OF LIQUID SCINTILLATION COUNTING AND AUTORADIOGRAPHY FOR DETECTING TRITIUM IN SPERMATOZOA. Hunt, W. L.; Foote, R. H. (Cornell Univ., Ithaca, N. Y.). Radiat. Res., 31: 63-73(May 1967).

Assays by autoradiography (grain counts) and liquid scintillation (disintegrations per minute, dpm) were made on semen samples collected from 5 rabbits for 63 days following injection with ^{3}H-thymidine. The mean grain counts and mean dpm determined on semen samples containing radioactive spermatozoa were highly correlated ($r = 0.93$, $P < 0.001$). With this high relationship it was possible to calculate a meaningful regression of mean grain counts on dpm. It was found that 5.8 disintegrations were required per grain observed in NTB-3 emulsion for an autoradiographic efficiency of 17.3%. Utilizing direct sample preparation, liquid scintillation counting was demonstrated as a rapid method to detect initial appearance of ^{3}H-labeled spermatozoa. The correlation coefficient calculated for counts obtained on duplicate subsamples was 0.99. The efficiency of the procedure was estimated by means of external standards to range from 9.8 to 12.5%. Inclusion of thixotropic gel reduced errors in counting, but actual solidification of the mixture was not necessary, as nongelled and gelled samples averaged 1293 and 1202 dpm, respectively. (auth)

32672 PVC SUITS FOR PERSONAL PROTECTION AGAINST RADIOACTIVE CONTAMINATION. Suter, Fred (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Atompraxis, 13: 180-5(Apr.-May 1967). (In German).

The Eidgenoessische Institute for Reactor Research (EIR) at Wuerenlingen has developed in collaboration with Pedrolit, Zürich, PVC protection suits. The suits are for use by operators who must be protected against radioactive contamination. The pressure suits with clean air supply are especially designed for use in presence of tritium. The physiological conditions existing in the pressurized suits and their permeability for tritium were studied. (auth)

32673 DETERMINATION OF ^{60}Co TO Co RATIO FOR THE ESTIMATION OF FAST NEUTRON DOSE FROM THE ATOMIC BOMBS IN HIROSHIMA AND NAGASAKI. Kawamura, S.; Izawa, M.; Maruyama, T.; Tanaka, E.; Hashizume, M. (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys., 13: 801-6 (July 1967).

It was proposed by Saito et al., to estimate thermal neutron flux from the bomb explosions by measuring the induced radioactivity in Co contained in ferrous materials. The present authors estimated the dose due to fast neutrons in a similar way. A procedure is described for determination of the ratio ^{60}Co to Co due to the reaction $^{59}Co(n,\gamma)^{60}Co$. It was estimated that the specific activity of the cobalt would be of the order of $\mu\mu Ci/mg$. Samples of iron used were about 50 g. As only the ratio of ^{60}Co to Co was required, emphasis was placed on purifying the cobalt chemically and radiochemically, rather than on quantitative extraction. The iron was removed and the cobalt purified by ion exchange techniques, and cobalt was determined by absorptiometric methods. Details are given of sample preparation, and determination of ^{60}Co activity. Values for samples collected at 120 to 1300 m from the hypocentres are shown graphically. The logarithms of ^{60}Co to Co ratios decreased almost linearly with distance. Values for sites less than 1300m from the hypocentres are considered to be significant compared with background level. (UK)

32674 RADIATION VERSUS CANCER. Campion, P. J. (National Physical Lab., Teddington, Eng.). New Sci., 34: 760-3(June 29, 1967).

The techniques of radiation therapy are discussed, together with dose measurement problems that arise. (UK)

32675 GAMMA DOSE RATE AT AN EXTERNAL POINT ON THE AXIS OF A SOLID RADIOACTIVE SPHEROID SOURCE. Gupta, P. C.; Jain, J. P.; Gupta, M. M. (Inst. of Nuclear Medicine and Allied Sciences, Delhi). Int. J. Appl. Radiat. Isotop., 18: 449-56(July 1967).

An expression is derived for the γ dose rate at an external point on the axis due to a spheroidal source with uniform distribution of radioactivity. The values for the spheroidal source are compared with those of point, spherical, and cylindrical sources. The effect of change of geometrical configuration on the dose rate was studied in detail using an IBM-1620 computer. (auth)

32676 AN EVALUATION OF ^{60}Co ROTATIONAL TELETHERAPY EQUIPMENT. DeVore, Waldo D.; Greenlaw, Robert H. (Univ. of Kentucky, Lexington). Amer. J. Roentgenol., Radium Therapy Nucl. Med., 99: 600-5(Mar. 1967).

It is obvious from this study that one must calibrate output for each beam area used. The competence of the installation of the equipment in this respect is extremely important. This is critical work and needs to be accomplished by persons knowledgeable in the matters which critically affect function. More of this sort of evaluation of equipment by users will be of real value. (auth)

32677 SREDSTVA INDIVIDUAL'NOI ZASHCHITY PLYA RABOT S RADIOAKTIVNYMI VESHCHESTVAMI. (OPYT SOZDANIYA KONSTRUKTSII METODY OTSENKI, REZUL'TATY ISSLEDOVANII). (Means for Individual Protection for Personnel Handling Radioactive Substances. Construction, Evaluation, and Investigative Methods). Gorodinskii, S. M. Moscow, Atomizdat, 1967. 223p.

The principal domestic and foreign materials for use in protective clothing for the protection of personnel working with radioactive substances are reviewed. A description is given of the basic construction of clothing and respirators for the individual protection of the respiratory organs and skin coverings, designed for use under different industrial conditions. Methods for the evaluation of the efficiency of means for individual protection, their use, and their repair are given. (tr-auth)

Medicine

Refer also to abstracts 32096, 32616, 32667, 32674, 32676, 32745, 32764, and 32783.

32678 (CONF-661018, pp 208-12) ETHICAL CONSIDERATIONS IN HUMAN EXPERIMENTATION. Andrews, G. A. (Oak Ridge Associated Universities, Inc., Tenn.).

A discussion on ethical considerations in human experimentation is presented. (B.H.S.)

32679 (RM-5140-TAB) DIMENSIONS OF SURVIVAL: POSTATTACK SURVIVAL DISPARITIES AND NATIONAL VIABILITY. Hanunian, Norman (RAND Corp., Santa Monica, Calif.). Nov. 1966. Contract AT(04-3)-414. 225p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The compositional changes that might be produced in the structure of American society by massive nuclear attack were studied. The study proceeds from consideration of essentially demographic entities to economic ones, examining the full range of economic activities by reference to a disaggregation of the labor force and to certain other indicators. It is concluded that nationwide results generated with respect to economic variables seldom show any very consequential-looking disparities except where farm entities are compared with nonfarm entities, in which case the comparisons generally favored the farm entities. A Cobb–Douglas model was used to account for the contributions to output made by surviving labor and capital. (H.G.D.)

32680 (SRI-4949-130) POSTATTACK RECOVERY OF DAMAGED URBAN AREAS. LaRiviere, Philip D.; Lee, Hong (Stanford Research Inst., Menlo Park, Calif.). Nov. 1966. Contract OCD-PS-64-201. 63p.

The report presents mathematical formulas and computational procedures for assessing damage due to blast and fire and for estimating the fallout hazards from nuclear detonations in urban areas. Major consideration is directed to the delineation of the damage areas for the purpose of defining the locations and the extent of the areas in which clearance and repair operations could be carried out. The constraints on these operations are determined by estimating not only the extent of the combined nuclear effects of blast, fire, and fallout radiation but also the timing of the events in the developing environment. The net result of applying the procedures is a definitive description of the prerecovery state of the urban population, urban facilities, and urban resources that would be available for use in recovery operations. (auth)

32681 ISCHAEMIA DETECTING RADIOACTIVE SUBSTANCES FOR SCANNING CARDIAC AND SKELETAL MUSCLE. Malek, P.; Ratusky, J.; Vavrejn, B.; Kronrad, L.; Kolc, J. (Inst. for Chemical and Experimental Surgery, Prague. Inst. of Organic Chemistry and Biochemistry, Prague. Research Inst. for Medical Use of Radioisotopes, Prague. Inst. for Nuclear Research, Prague). Nature (London), 214: 1130-1(June 10, 1967).

Some tetracyline antibiotics accumulate and are retained in injured tissues, including ischaemically altered myocardium, the striated muscles, and the kidneys. Studies are described employing ^{131}I-labeled tetracycline derivatives thought to be suitable for scanning pathological foci. Results are tabulated. Other studies were conducted with ^{197}Hg- or ^{203}Hg-labeled hydroxymercurifluorescein derivatives. In order to obtain an exact evaluation of these substances they were screened together with neohydrin-^{203}Hg which had been tested for scanning infarctions of the myocardium in rats. The labeled fluorescein derivatives were applied to dogs with myocardium infarction. Scanning was performed in vivo, and on the heart removed from the body. The presence of myocardial infarction could be demonstrated in vivo by identification of the "hot" area, although the focus of infarction was considerably hemorrhagic. The ischaemic sites corresponded exactly to the sites of accumulation of radioactivity. Results were not so good using neohydrin-^{203}Hg, and scanning in vivo was unsuccessful. With regard to the fluorescein derivatives, it may be possible to use these in human medicine, particularly with ^{197}Hg labeling. (UK)

32682 RADIOSENSITIVITY OF MALIGNANT MELANOMA IN MAN. Sakhatchiev, A.; Raichev, R.; Ivanova, M. (Scientific-Research Oncology Inst., Sofia). Med. Radiol., 12: No. 6, 35-40 (June 1967). (In Russian).

For the purpose of studying the radiosensitivity of malignant melanoma in man the authors irradiated multiple metastases in the skin with different single and total doses. The tumor was removed at different time intervals. This method excluded the influence of many variable factors impeding the correct assessment of the radiosensitivity of malignant melanoma. Single doses ranged from 200 tc 3,003 RAD total doses—from 600 to 15,000 RAD. The authors established a significant radioresistance of all the tumors irradiated. A single dose exceeding 500 RAD caused a marked vasodilatation with the presence in some cases of neoplastic emboli in the vessels. At the same time the destructive effect of these doses in similar total doses was weaker. This gives grounds to suppose that in radiotherapy of malignant melanoma the single dose should not exceed 500 RAD. (tr-auth)

32683 INTRATISSUE RADIOTHERAPY OF CEREBRAL TUMORS. Ugryumov, V. M.; Volkov, A. A.; Vaskin, I. S.; Zhagrin, A. G.; Zemskaya, A. G.; Khilkova, T. A.; Khokhlova, V. V.; Vakhnovetskii, B. P.; Nikulenko, E. L.; Balamutova, M. P. Med. Radiol., 12: No. 6, 3-8(June 1967). (In Russian).

The authors depict the ten-year experience of the Leningrad Neurosurgical A. L. Polenov Institute on combined (surgical and radiation) treatment of 132 patients suffering from brain tumors with the use of radioactive preparations. In cystose-degenerated tumors, neoplasms of the ventricular system and medulloblastoma of the cerebellum the authors used colloidal ^{198}Au and $Cr^{32}PO_4$ (65 patients). The best results were achieved in intracavitary irradiation of craniopharyngioma—17 cases of positive results out of 23 patients treated. Intraventricular injections of radiocolloidal substances in ventricular tumors are of practical value. The results of such treatment in 7 patients were: softening of the syndrome of closed hydrocephalus and remissions (in some cases up to 2 to 10 years). The radiosurgical method with the use of ^{198}Au and ^{90}Y granules was employed in 67 patients suffering from solid forms of cerebral tumors. In 30 cases a stable curative effect was achieved (follow-up—2 to 7 years). Intratissue gammatherapy with ^{198}Au granules is characterized by massive local changes and protracted post-radiation processes. By the criterion of life expectation (observation over one year) a positive effect was attained in 72 (54.5%) cases. The data obtained testify to the necessity of further development of intratissue and intracavitary radiotherapy in the radiosurgical complex of treating patients with inoperable tumors of the brain. (tr-auth)

32684 CHANGES OF THE BONE TISSUE IN RADIOTHERAPY OF CANCER OF THE ESOPHAGUS. Savchenko, E. D.; Osipenkova-Vichtomova, T. K. Med. Radiol., 12: No. 6, 41-9(June 1967). (In Russian).

The paper describes the changes occurring in the bone tissue of 10 deceased patients with esophageal cancer in connection with their treatment on the apparatus GUT-Co-400 and 25 MeV betatron. The age of the deceased ranged from 39 to 82 years. During bremsstrahlung betatron radiation in the total dose per focus varied from 960 to 8,400 RAD, whereas in distance gammatherapy—from 1,975 to 9,500 RAD. The patients died 8 to 210 days after the end of treatment. Subject to meticulous pathologico-anatomical investigation were: the ribs, sternum, vertebrae, cranial bones, head and diaphysis of the femur and humerus. As control the authors studied the respective bones in 10 patients who died of cancer of the esophagus and were not subjected to irradiation. (tr-auth)

32685 SUBSTANTIATION OF X RAY THERAPY OF CERVICAL MIGRAINE. Faizullin, M. Kh.; Ratner, A. Yu.; Chizhova, E. I. Med. Radiol., 12: No. 6, 50-3(June 1967). (In Russian).

Cerebral disturbances in cervical osteochondrosis are encountered often, however, in respect to the choice of the mode of therapy there are many contradictions. The authors are of the opinion that in routine cases of cervical migraine it is preferable to use novacain-electrophoresis, diathermia, hydrotherapy in combination with medicinal agents, whereas in severe cases and in the presence of secondary diencephalic disorders it is expedient to employ roentgen treatment in the form of irradiation of the cervical region of the spine. X-ray therapy was used in 60 out of 260 patients with cervical migraine. The efficacy of radiation treatment is explained by the action on the posterior cervical sympathicus, analgesic effect and reduction of periarterial induration of soft tissues. The expediency of X-ray therapy of cervical migraine is substantiated by the dynamics in the content of bromine in the blood urinary excretion of steroid metabolites and changes on rheoencephalograms. The irradiation was carried out with two fields measuring 4 × 10 cm, in a single exposure dose of 50 to 60 R (6 to 8 irradiations per course of treatment). The results are positive. (auth)

32686 DISTRIBUTION OF RADIATION DOSAGES AND ESTIMATION OF THE ABSORBED ENERGY DURING ROENTGENOSCOPY OF THORACIC ORGANS IN CHILDREN. Ul'yanov, A. I. Med. Radiol., 12: No. 6, 56-63(June 1967). (In Russian).

Experiments were conducted on paraffin, osteo-paraffin phantoms and on a child's cadaver. A more appropriate idea as to the distribution of radiation doses during roentgenoscopy of the thoracic organs yield findings obtained in experiments on an osteo-paraffin phantom. Differences between these data and results consequent to measurements made on the cadaver can be taken due account of. Results derived from measurements made on the cadaver are comparable with factual dosage distribution. As evidenced by investigations during roentgenoscopy of the thoracic organs in children a large dose of scattered radiation in remote areas of the body is formed. In nurslings the radiation load on gonads is 10 times as high as in adolescents aged 15 to 16 years. Female gonads get a much higher dose of scattered radiation than do those of the males. (tr-auth)

32687 RADIOTHERAPY IN INOPERABLE TUMORS OF THE ABDOMINAL CAVITY AND RETROPERITONEAL SPACE. Kozlova, A. V.; Lopatnikova, E. F. *Med. Radiol., 12: No. 6, 8-13 (June 1967). (In Russian).

The article discusses the possibility of distance gamma-therapy in inoperable tumors or relapses after the surgical treatment of cancer of the stomach, large intestine and some tumors of the retroperitoneal space. In the presence of ascites or dissemination in the abdominal cavity, distance gamma-therapy was combined with intracavitary introduction of radiogold. In relapses of cancer of the stomach a stable remission could not be achieved, the patients lived slightly over one year after radiotherapy. In inoperable relapses of cancer of the large intestine in a number of cases a radical operation is possible. In neoplasm of the retroperitoneal space in some cases an operable state could be achieved; in other instances—the tumor undergoes complete regression. Notwithstanding irradiation of the abdominal cavity in a sufficiently high dose, the subsequent operations ran a course without complications. (auth)

32688 RADIOTHERAPY OF JUVENILE ANGIOFIBROMA OF THE BASE OF THE SKULL. Bal'sevich, S. Ya.; Bentsianova, V. M.; Litvakovskaya, G. A. Med. Radiol., 12: No. 6, 13-20 (June 1967). (In Russian).

An analysis of the results of distance gamma-therapy performed in 12 patients with angiofibroma of the base of the skull showed that the method of choice in the treatment of this kind of tumors is a combination of radiotherapy with subsequent operation. Preoperative irradiation leads to a reduction of the tumor, decrease of hemorrhage, thus facilitating the task of operative removal. In two inoperable patients after gamma-therapy against the background of clinical improvement roentgenologically there was established a drop in the size of angiofibroma. During the choice of the method of irradiation preference should be given to high-energy radiation. (tr-auth)

32689 DISTRIBUTION OF DOSE FIELDS IN DIFFERENT METHODS OF DISTANCE RADIOTHERAPY OF MAXILLARY TUMORS. Balmukhanov, S. B.; Borisevich, N. V.; Dzholdybaev, M. S.; Zholkiver, K. I.; Zevrieva, I. F. Med. Radiol., 12: No. 6, 20-31(June 1967). (In Russian).

The authors discuss the results of dosimetric studies on heterogeneous phantom in distance radiotherapy of maxillary tumors. The distribution of dose fields were determined for conditions of static gamma-therapy, a linear accelerator with an energy of 3 MeV (2, 3, 4 irradiation fields) using wedge-like lead filters, and sector irradiation using x-ray apparatus and γ sources. It was found that two-field irradiation does not give a satisfactory dose distribution. The special distribution is improved considerably in reduction of the size of irradiation fields and increase of their number to 3 to 4, as well as in the use of wedge-like filters. In sector x- and gamma-therapy, the radiation loading on the eye and brain does not exceed such in static irradiation. (tr-auth)

32690 SIGNIFICANCE OF THE RADIATION DOSAGE RATE IN SHORT-RANGE X RAY THERAPY OF SKIN CANCER. Yablenik, E. B. (Orenburg Medical Inst., USSR). Med. Radiol., 12: No. 6, 32-5(June 1967). (In Russian).

When practicing treatment at a radiation dosage rate of 50 R/min in $^2/_3$ of all observations the subsiding reaction after completion of the therapy was followed by the appearance of residual tumors, whereas treatment at a dosage rate of 375–400 R/min resulted in the great majority of instances in timely recovery of the patients. Delayed cure after application of a high radiation dosage rate is to be attributed to a weakened thermal reaction of the focus surrounding skin and also to the lengthened chronaxy following termination of the treatment. Delayed cure after application of a low radiation dosage rate can be less frequently connected with the cited above features specific to the reactivity. Frequent presence of residual tumors after irradiation at a dosage rate of 50 R/min may be explained by an insufficient action exerted on the tumor by the low-intensity radiation. With a low radiation dosage rate changes occurring in the tissues restored at the site of the focus are often noted to appear in cases of delayed cure. With a high radiation dosage rate the said changes are recorded in a considerable number of patients also with their timely recovery. Most effective proves to be irradiation at medium dosage rate (of the order of 180–230 R/min), when timely recovery is seen to occur in most instances, alterations in the restored tegument appearing but seldom. (tr-auth)

32691 THE STATE OF ORGANS OF THE GASTROINTESTINAL TRACT IN MACACO MONKEYS IN ACUTE RADIATION SICKNESS ACCORDING TO ROENTGENOLOGICAL DATA. Lemberg, A. A.; Simavonyan, V. G. Med. Radiol., 12: No. 6, 64-9 (June 1967). (In Russian).

The paper presents the results of functional studies of the gastrointestinal tract in 50 macaco monkeys subjected to whole-body gamma-irradiation in doses ranging from 630 to 720 R. The investigations were carried out for a prolonged period of time embracing different periods of development of acute radiation sickness. The authors revealed different changes of the secretory, motor and evacuatory function of the stomach and intestine. (tr-auth)

32692 INVESTIGATION ON THE COMBINED EFFECTS OF 5-BROMOURACILDESOXYRIBOSIDE AND X RADIATION ON ANIMAL TUMORS. Maass, Heinrich; Grote, Karl Heinrich (Univ., Hamburg). Strahlentherapie, 133: 102-7(May 1967). (In German).

The Yoshida sarcoma of the rat and the Ehrlich carcinoma of the mouse were used to determine if an application of 5-bromouracil-2-desoxyriboside (BUdR) can cause a radiation sensitization of the tumor during the tumor growth. No toxic side effects, even after application of high BUdR doses, were observed. BUdR did not inhibit the transplantation and growth ability of the tumors. A minor but not very convincing positive effect in regard to radiosensitization was obtained in subcutaneous tumors and with certain moderate radiation doses. From the results it might be concluded that an increase in radiation sensitivity of transplantation tumors could not be obtained by the application of BUdR. (auth)

32693 ASSESSMENT OF CONDITIONS OF WORK AND STATE OF HEALTH OF MEDICAL ROENTGENOLOGISTS. Soldatova, V. A.; Kirsanova, G. I. Med. Radiol., 12: No. 6, 73-9(June 1967). (In Russian).

The article is concerned with the outpatient examination of 990 roentgenologists and inpatient examination of 125 persons. An analysis of studies of the outpatient group showed a quite satisfactory state of health of roentgenologists. The symptom-complex of chronic radiation sickness was revealed only in 1% of cases in persons working in the past with above-standard loadings. Upon a meticulous examination the authors established some insignificant deviations in the state of health, which correlated with the total irradiation dose: a predisposition to hypotension, tachycardia, greater incidence of the syndrome of neurocirculatory dystonia, reticulocytosis and an increased number of cases with an accelerated erythrocyte sedimentation rate. The authors found no distinct relationship between the incidence of diseases of the nervous system and changes in the generative and ovarian-menstrual function and the level of irradiation. Special attention is drawn to the greater incidence of changes in the skin of hands with disorders of the capillary circulation and surface sensitivity, and in a number of cases with concomitant trophic changes in the skin of fingers. Clinical observations confirmed the authors' suppositions on the peculiar reaction of the organism to this occupational effect, caused by the relative irregularity of irradiation of individual areas of the body, and the relative "softness" of roentgen irradiation. (tr-auth)

32694 POTENTIAL ANTIRADIATION DRUGS: α-ALKYLOXIMINONITRILES. Coviello, Dominick A. (Univ. of Illinois Medical Center, Chicago). J. Pharm. Sci., 56: 307(Feb. 1967).

Of nine α-alkyloximinonitriles prepared as potential radioprotective agents, three were tested. Two were very toxic and inactive, while one with low toxicity gave slight protection. Nitriles have shown varying degrees of protection against radiation damage in mammals, and it has been suggested that the nitriles act by the slow sustained-release of HCN that has a protective effect. It is postulated that α-alkyloximinonitriles, reacting with water in the cellular milieu, could yield an intermediate which would decompose to yield HCN and an O-alkylhydroxamic acid according to a scheme that is outlined. It was found that 1-benzyloximinobutanecarbonitrile gives slight protection and had an LD_{50} of about 1000 mg/Kg, while 2 other compounds, 1-benzyloximinopropanecarbonitrile and 1-benzyloximinoheptanecarbonitrile, gave no protection, with LD_{50}'s of less than 50 mg/Kg. (BBB)

32695 REGIONAL HEART ^{42}K CLEARANCE DETERMINED BY COMPUTER ANALYSIS OF SERIAL DIGITAL SCANS. Smith, R. O.; Love, W. D. (Univ. of Mississippi, Jackson). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 683-5(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

Medical scanning procedures which provide a visual image of the distribution of a radioisotope in internal organs are customarily done using nuclides which emit gamma rays of relatively low energy. In the study of deeply placed organs, such as the heart, most of the radiation is absorbed or scattered by tissue located between the site of interest and the detector. Through the use of ^{42}K (1.5-MeV gamma) and heavily shielded detectors, satisfactory visualization of the regional tracer uptake in the heart muscle were obtained. In order to separate radioactivity originating in muscle from that in the circulating blood, a regression analysis of the changes in counting rate with time at each of 960 locations was made by computer processing of serial scans. (auth)

32696 USE OF BENZIDAMINE FOR CURING OF MUCOUS MEMBRANE IN COURSE OF RADIOTHERAPY DURING INITIAL STAGES OF DEGENERATION. Maestro, A. (Univ., Padua). Radiobiol. Radioter. Fis. Med., 22: 43-55(Jan.-Feb. 1967). (In Italian).

After having briefly explained the characteristics of the reactions of the mouth mucous membrane during radiotherapy with high energy electrons, the efficiency of benzidamine in the prophylaxis and therapy of mucous lesions were considered. The results obtained using the drug with two groups of patients undergoing radiation therapy confirmed the analgetic-antiphlogistic properties of benzidamine and its usefulness for treatment and prophylaxis of mucous lesions due to rays. (auth)

32697 DISTRIBUTION OF NEW FLUORENE DISULPHONAMIDO DERIVATIVES IN RATS WITH TRANSPLANTED WALKER CARCINOSARCOMA. Malejka, Danuta (Medical Academy, Poznan, Poland). Brit. J. Cancer, 20: 857-70(Dec. 1966).

Five new radioactive compounds: N,N'-bis(carbamyl)-2,7-fluorene[^{35}S]disulfonamide, (III), N,N'-bis(p-tolyisulfonyl-carbamyl-n-butyl)-2,7-fluorene[^{35}S]disulfonamide, (IV), N,N'-bis(4-carboxyphenyl)-2,7-fluorene[^{35}S]disulfonamide, (V), N,N'-bis(5(6)-nitrobenzimidazolyl)-2,7-fluorene[^{35}S]disulfonamide, (VI), and N,N'-bis (6(2,4-dimethoxypyrimidyl))-2,7-fluorene[^{35}S]disulfonamide, (VII), were synthesized, and their tissue distribution 6 hrs after a single intravenous injection to tumor-bearing (Walker carcinosarcoma) and tumor-free Wistar rats was studied. The data obtained are discussed in relation to the bis-thiazole (Compound I) and bis-guanidyl (Compound II) derivatives examined previously. The similarity of chemical structure of the substituents at 2,7-disulfonamido-fluorene draws a line of common factors in the behavior of Compounds II and III, Compounds IV and VI, and Compounds I and VII. The distribution data for these paired compounds are similar. Compounds II and III are not present in tumor. The concentration in tumor of Compounds IV and VI is very similar and reveals favorable ratios for red blood cells, liver, lungs (statistically significant), and for plasma, leg muscle and carcass for both compounds, and also for spleen and kidneys for Compound IV. The highest concentration in tumor (77 μg/g tissue) is achieved with Compound VII and this value gives favorable ratios for red blood cells, plasma, lungs, leg muscle and carcass (all statistically significant). The present studies show an impaired elimination of fluorene disulfonamides in presence of tumor with Compounds III, V and VII. Four of the examined compounds (IV, V, VI and VII) tend to localize in the liver and spleen of tumor-free rats to a greater extent than in tumor-bearers, thus showing a weakened phagocytic function of the reticulo-endothelial system in the presence of tumor. (auth)

32698 INTERSTITIAL IRRADIATION OF THE PITUITARY GLAND FOR ADVANCED CARCINOMA OF THE BREAST USING THE TRANSETHMOIDAL APPROACH. Greening, W. P.; Thompson, S. Graham (Royal Marsden Hospital, London). Brit. J. Cancer, 20: 703-8(Dec. 1966).

Forty-two cases of advanced carcinoma of the breast that were treated by transethmoidal implantation of the pituitary gland with radioactive gold or yttrium are reviewed. In only three of these did complications occur, and were temporary in two: no cases of meningitis occurred. The average duration of survival after the implant was 10.3 months and sixteen patients (38%) were improved symptomatically by the procedure. The recent literature is reviewed, and the advantages of the transethmoidal route are discussed. (auth)

32699 OBSERVATIONS ON PATIENTS WITH CEREBRAL ASTROCYTOMA (GLIOBLASTOMA MULTIFORME) TREATED BY IRRADIATION UNDER WHOLE-BODY HYPOTHERMIA. Bloch, M.; Bloom, H. J. G.; Penman, J.; Walsh, L. (Atkinson Morley's Hospital, London. Royal Marsden Hospital, London). Brit. J. Cancer, 20: 722-8(Dec. 1966).

Thirty patients suffering from cerebral glioblastoma multiforme (astrocytoma grades III and IV) were treated by surgery, followed by irradiation to the brain under conditions of mild whole-body hypothermia (30 to 33°C.). Under these conditions there is an increase in the sensitivity of cerebral tissues such that patients will tolerate an incident dose of 200 R daily, to each cerebral hemisphere, for not longer than three consecutive days. There is some evidence that the response of the tumor is greater than that of normal brain tissue. However, life was not prolonged by this treatment. Ten patients died during treatment. The mortality for the total number of episodes of hypothermia was 12.5%. The high case mortality was considered to be due largely to the combined effects of hypothermia plus irradiation and not from the hypothermia alone. It is suggested that an increase in radiosensitivity may also be a property of other tissues of the body during mild whole-body cooling. Changes in hematocrit and hemoglobin values, in red and white cell count and in platelet count during prolonged hypothermia were described. Increase in cerebrospinal fluid protein was observed in a small number of patients during cerebral irradiation under hypothermia, and during rewarming following hypothermia, with or without irradiation. Five patients developed temporary partial deafness and one of these complained also of impairment of sense of taste and smell following irradiation to the brain under hypothermia. Acute pancreatitis occurred in two patients and acute epididymo-orchitis in one patient during 80 episodes of prolonged hypothermia. (auth)

32700 RADIATION-INDUCED NEUROFIBROMATA. Donohue, William L.; Jaffe, Frederick A.; Rewcastle, Neill B. (Univ. of Toronto. Hospital for Sick Children, Toronto. Toronto Western Hospital. Toronto General Hospital). Cancer, 20: 589-95 (Apr. 1967).

Two cases are reported of neurofibromata occurring as a late complication of radiotherapy which was given during childhood. In neither case was there any stigmata of neurofibromatosis. In both cases the neurofibromata arose in the cervical region and only in the field of irradiation. One occurred 13 and the other 11 years after the putative course of irradiation. (auth)

32701 EXPERIMENTAL OBSERVATIONS OF THE EFFECTS OF COLLOIDAL RADIOGOLD ON EHRLICH ASCITES TUMORS. Martinenghi, C.; Gallico, E.; Morvillo, V. (Univ., Milan). Radiobiol. Lat., 7: 97-106(1964). (In Italian).

To reveal the effect on the Ehrlich ascites tumor of the mouse of radiotherapy with colloidal ^{198}Au introduced into the peritoneal cavity in doses equivalent to those used in clinical practice, the authors examined the variations of the body weight and the length of survival in two groups of test animals and in a control group. The animals of one group were injected with 100 μC of ^{198}Au 7 days after the implantation of the ascites tumor; those of the second group were given 400 μC 7 days, and again 400 μC 11 days after the transplantation. The injection of 100 μC of radiogold (which corresponds to an absorbed dose of approximately 1000 RAD) led only to a transient arrest of the weight gain and had no influence on the duration of the survival. The animals of the group treated with 400 + 400 μC (a total absorbed dose of 8,000–10,000 RAD) showed a great loss of weight, which fell below the initial weight, so indicating the arrest of the growth of the neoplasm. Of the animals in this group, 4 out of 5 were still alive 31 days after the tumor transplantation, the end of the period of observation, and at that time showed no signs of recurrence of the tumor growth, whereas all the animals in the other groups were dead 22 days after the transplantation. (auth)

32702 THE NEW ^{113}Cd–^{113m}In MEDICAL ISOTOPIC GENERATOR. Pal, Imre; Torko, Janos; Gacs, Janos; Klityina, R. G.; Farkas, Gyorgy (National Atomic Energy Commission, Budapest. Medical Univ., Budapest). Atomtech. Tajek., 9: 515-27(1966). (In Hungarian).

Short half-life isotopes are preferred in medical practice because the labeled radioactive excretions, such as urine or stool, may be handled as cold products. However, these isotopes cannot be used far from their place of preparation. The problem may be overcome by using a long half life isotope with a short half life daughter; these requirements are satisfied by the ^{113}Cd–^{113m}In generator, in which the ion-exchange method was used to separate off the daughter products. The ^{113m}In-labeled indium phosphate colloids, DTPA and citrate complexes were tested using rats and their applicability for human diagnostics was examined. The monoenergetic, 0.335-MeV γ radiation was found to be advantageous from the viewpoint of instrumentation. The diagnostic data obtained agreed with those yielded by means of other isotopes that expose patients to a greater radiation dose. The labeled compounds needed can be easily fabricated in clinical laboratories. (TTT)

32703 EFFECTS OF FOLIC ACID ON DNAase ACTIVITY OF THE BRAIN IN GUINEA PIGS WITH ACUTE RADIATION SICKNESS. Kucherenko, M. E. (Kiev State Univ.). Ukr. Biokhim. Zh., 39: 174-8(1967). (In Ukrainian).

After 30 min of whole-body x irradiation in doses of 2000 R, the DNAase activity decreased 1.7 times. After 3 hrs of irradiation it was 1.5 times greater than the norm. The DNAase activity exceeded the norm during the first day. Greatest inhibition of DNAase activity was observed on the 2nd and 3rd days postirradiation, and inhibition persisted to the end of the 4th and 5th days. Folic acid stabilized DNA activity during acute radiation sickness. Continuous administration of folic acid to normal animals inhibited DNAase activity for five days. (auth)

32704 ULTRA FINE-GRAINED EMULSIONS FOR AUTORADIOGRAPHY. Perfilov, N. A.; Novtkova, N. R.; Zakharov, V. I.; Fadina, E. V.; Shmantsar, I. A. (Radium Inst., Leningrad. Inst. of Cytology, Leningrad). Tsitologiya, 9: 624-9(May 1967). (In Russian).

The main properties of PR-2 and P-9r fine-grained photographic emulsions are dealt with, e.g. the average AgBr crystal diameter (0.12 and 0.06 μ, respectively), the resolving power (480 lines per mm), the gamma coefficient, sensitivity to charged particles, etc. The information concerning the methods of preparation of radioautographs, the contents of developer and photographic processing of layers of the above emulsions is also given. The emulsions were synthesized at the Radium Institute and are employed both in contrast and track autoradiography and in the electron microscope beta-radiography. (auth)

32705 INFLUENCE OF BONE MARROW TRANSPLANTATIONS ON THE MITOTIC ACTIVITY OF SPLEEN CELLS OF THE IRRADIATED MICE. Ogandzhanyan, E. E.; Saakyan, D. G. (Radiobiology Section, Ministry of Public Health, Erevan). Tsitologiya, 9: 583-8(May 1967). (In Russian).

A general and once repeated irradiation of black mice of line $C_{57/6}$ by a 600 R dose from the first days after the treatment shows a sharp depression of the mitotic activity of spleen cells. The recovery process begins on the 14th day following the irradiation. During the period of an intensive cell division some qualitative disturbances of mitosis are observed in the form of chromosome aberrations. At the intraspleen transplantation of the bone marrow, the restoration of proliferation in the spleen cells begins from the 9th day. At a combined influence with sinestrol this may be seen on the 5th day, the recovery proceeding more intensively and the living cells being formed in greater quantities. (auth)

32706 COMPARATIVE OBSERVATIONS OF LEUKOCYTE LOSS FROM ANTIMITOTIC PHARMACEUTICALS AND PAN-IRRADIATION OF RATS. Martinenghi, C.; Castellano, E.; Riccardi, A.; Morvillo, V.; Baraldi, C. (Univ., Milan). Radiobiol. Lat., 7: 21-31(1964). (In Italian).

Three groups of Norwegian albino rats were given, respectively, whole-body irradiation with 250 R in a single dose; an i.p. injection of 15 mg of cyclophosphamide (Endoxan), i.e., approximately 60 mg per kg body weight; and an i.p. injection of 0.14 mg of trisethylene imino-benzoquinone (Trenimon), i.e., approximately 0.56 mg per kg body weight. For each of these three forms of treatment, the dose selected amounted to approximately one-third of the $LD_{30/30}$ for rats. In blood samples taken from the dorsal vein of the tail, the degree of decrease in the total leukocyte count, and in the lymphocytic and granulocytic components was determined. Samples were then regularly taken for a period of 45 days after the treatment, in order to determine the rapidity and pattern of normalization of the leukocytes. Trenimon proved to have very little leukopenic effect, and normal values were rapidly regained. Endoxan brought about a more marked decrease in the leukocytes, with involvement of both the lymphocytes and the granulocytes. Its effect was rapidly overcome, and it took only 10 days for the leukocyte count to return to normal. The whole body irradiation caused a pronounced leukopenia, and affected primarily the lymphocytes: that the germinal strains were affected is indicated by the slowness of the return to normal. The quantitative difference between the reaction of the lymphocytes and that of the granulocytes may indicate that these two groups of leukocytes have different degrees of radiosensitivity. On the basis of a statistical analysis of the findings (determination of the mean values, measurement of the dispersion, comparison of the mean values by the t method of Student), it is possible to determine the degrees of significance of the differences observed between the leukocytic responses of the three experimental groups studied and the differences between the values observed in these groups and the normal values. (auth)

32707 ON THE RADIOPROTECTIVE EFFECTS OF CYSTEAMINE IN EPITHELIAL AND MESENCHYMAL CELLS CULTIVATED IN VITRO. Sanfilippo, S. (Univ., Catania, Italy). Radiobiol. Lat., 7: 45-54(1964). (In Italian).

A study was made of the effect of small doses of ionizing radiations on fibroblasts and on pigmented epithelial cells of the retina of chicken embryos cultured in vitro. A brief summary is given of the various biochemical aspects of the action of ionizing radiations on the cell, with presentation of data from the literature on the subject. The doses of irradiation on the cells cultured in vitro were 2.8 R per minute. In the course of the experiment, the following were recorded: the mitotic index, the frequency of cytolysis, and of nuclear pyknosis. In fibroblasts and in epithelial cells irradiated without mercaptamine, appreciable inhibition of mitoses and cellular damage were observed. The radioprotective action of mercaptamine was studied by added doses of the substance to the culture medium of the cells in vitro. A concentration of 0.1% mercaptamine proved to be toxic for the cells, but a concentration of 0.01% proved to be optimal from the point of view of protection against radiation. Lower concentrations of mercaptamine had no appreciable radioprotective effect. (auth)

32708 POSSIBILITIES OF THE PROPHYLAXIS AND THERAPY OF GENETIC RADIATION DAMAGE. Fritz-Niggli, Hedi (Univ., Zurich). Radiol. Clin. Biol., 35: 332-44(1966). (In German).

The dependence of genetic radiation damage on the age, metabolism, mitotic activity of the irradiated germ cells, the time distribution of the radiation dose, and various environmental factors indicate that the radiation mutations arise at the end of an effect change. Various pre-mutation states can be passed through up to the point the radiation damage is fixed as an irreversible mutation of the genetic material. It was experimentally observed that mutation frequency can be altered by treatment before, during, and after irradiation. The decrease of the O_2 content, inhibition of the metabolism, and fixation of radioresistant phases or elimination of radiosensitive stages are prophylactic. A retardation of the fixation of the mutation and support of the healing process are therapeutic. The energy metabolism is of special significance as, for example, the varying radiosensitivity of the germ cells with respect to the mutability can be influenced by the vulnerability of their mitochondria. The therapeutic effect of this support of the energy production must be limited to the restoration process in which the healing was promoted either directly or indirectly by reparation enzymes. An intact energy metabolism immediately after irradiation is most probably of significance for the healing process. (tr-auth)

32709 RADIOTHERAPY OF SQUAMOUS CELL CARCINOMA OF THE ORAL PORTION OF THE TONGUE. Fayos, Juan V.; Lampe, Isadore (Univ. of Michigan, Ann Arbor). Contract AT (11-1)-245. Arch. Surg., 94: 316-21(Mar. 1967).

Use of various types of radiation to treat 154 patients with lingual cancer from 1940 to 1959 is described, with data on clinical results and prevention and incidence of radioinduced complications. Until 1955 only orthovoltage radiation, generated at 200 to 220 KV, was available for external radiotherapy, so that great difficulty was encountered in delivering safely a lethal dose to the tumor without excessive osseous and soft tissue radiation damage. The acquisition in 1955 of ^{60}Co radiation materially enhanced the effective use of external radiotherapy. An optimal dose-time relation was evolved which achieved maximal tumor eradication at the price of limited and tolerable radiation damage of the lingual tissue. The use of thin-walled lead cones, custom-made for each lesion, a special chair for the patient and a clamp to hold the cone, and a special adapter for the x-ray tube head allowed use of this technique successfully. By introducing the cone through the open mouth, placing its end directly against the involved part of the tongue, the lesion was irradiated without radiation passing through the skin or the mandible. With ^{60}Co radiation the technical problems of delivering tumor doses in the range of 6000 to 7000 R to the primary tumor and when necessary to metastatic spread were greatly simplified. Significant acute skin reactions were no longer obtained and late radiation damage of the deeper soft tissues and of bone was minimized. In this series, 54 patients developed postirradiation complications: 53 instances of lingual tissue necrosis and 1 of mandibular osteonecrosis. The latter appeared 4 yr after radiotherapy with 200-KV x radiation. The soft tissue necroses varied from areas a few millimeters in dia which healed spontaneously in a few weeks to larger areas which required more time for self-healing. In no case was surgical excision required to eliminate the radionecrotic focus. Of 89 patients treated by peroral irradiation, 45 (50.5%) developed mucosal radionecrosis. Of 20 patients treated by Ra needle implant, alone or after external irradiation, 6 (30%) developed soft tissue necrosis. The necroses were superficial, limited in extent, and self-healing, requiring only conservative management. (BBB)

32710 THERAPEUTIC RESULTS AND INTRATHORACIC RADIATION REACTIONS IN THE THERAPY OF BRONCHIAL CARCINOMA BY FAST ELECTRONS. II. RADIATION REACTIONS. Loerbroks, B.; Schumacher, W. (Staedtische Klinik fuer Lungenkranke, Berlin-Wannsee, Ger.). Beitr. Klin. Erforsch. Tuberk., 131: 144-67(Dec. 2, 1965). (In German).

Complications of radiotherapy with 35-MeV electrons are reported, along with other clinical results, in 219 patients with bronchial carcinoma. (BBB)

32711 CHROMOSOMAL ABERRATIONS. Loughman, William D. (Univ. of California, Berkeley). New Engl. J. Med., 276: 642-3(Mar. 16, 1967).

Data suggested increased chromosome aberrations in hyperthyroid patients after ^{131}I therapy as compared to normal controls, but the increases were not demonstrated to be due to radiation alone. Over 1500 cells were used to establish normal control values; less than 500 cells were used to establish pretreatment control values. In many categories, no aberrations were found in

the pretreatment control group. In some, no aberrations were found in the normal group. These facts prevent analysis of the difference between control groups. Statements about the cause of aberrations in the experimental group cannot be made. The use of ^{131}I in the therapy of thyrotoxicosis is to be viewed with caution, but other reports indicate that no proved case of thyroid cancer due to ^{131}I has been observed in the 14 years of its use in over 100,000 individuals. It is concluded that if modification of use of ^{131}I is to be considered, more convincing data concerning its hazards must be made available. (BBB)

32712 RADIOISOTOPE SCANNING OF THE THYROID. **Quinn III, James L.; Behinfar, Mehdi (Northwestern Univ., Chicago). J. Amer. Med. Ass., 199: 920-4(Mar. 20, 1967).**

Use of various iodine radioisotopes and ^{99m}Tc for thyroid scanning are considered in terms of levels of unnecessary irradiation, instrumentation, and interpretation of the results. The ideal radionuclide for any organ imaging is one that has no β radiation, which is not detected externally by the scanner and irradiates the organ or body region without contributing to the diagnosis; a monoenergetic γ emission which can be counted and collimated efficiently; and a relatively short physical half-life so the organ will not be irradiated excessively after recording is completed. Iodine-131, the most common radionuclide used for thyroid scanning, has the disadvantage of emitting β radiation, which results in unnecessary irradiation of the thyroid gland. Iodine-125 has no primary β radiation, which reduces the irradiation of the thyroid despite its relatively long physical half-life. Iodine-123 is a promising radionuclide but is not readily available. Its short physical half-life (13-hr) and lack of β radiation are its major advantages. It delivers $\sim 1/10$ the radiation dose to the thyroid as compared with ^{131}I. These newer radionuclides permit larger tracer doses, which, in turn, create superior counting statistics and resolving ability; yet the radiation is within the acceptable dose range to the gland. Pertechnetate-^{99m}Tc is trapped but, unlike iodine, is not concentrated in the thyroid gland. A satisfactory thyroid scan can be obtained within 30 min of administration, revealing the same structural information as with radioiodine. However, there may be greater periglandular background, since pertechnetate equilibrates with the extracellular space of the body. (BBB)

32713 INTRA-ARTERIAL APPLICATION OF LARGE PARTICLES OF ^{90}Y FOR TREATMENT OF TUMORS. **Nolan, T. R.; Grady, E. D. (Piedmont Hospital, Atlanta). Minerva Med., 56: 2037-40(June 9, 1965). (In Italian).**

Technique, dosage, clinical results, and complications in the use of ^{90}Y to treat various types of malignancies in 51 patients are described. The ^{90}Y preparation used was in the form of particles 40 to 80 μ in dia with a sp act of 1 mCi/mg. They were injected in a saline suspension containing 12% dextran. Doses of 4 to 8 mCi/Kg body wt were injected in a variety of routes: intravenously and intra-arterially (pulmonary, carotid, iliac arteries, and abdominal aorta). Improvement attributable to ^{90}Y injections was noted in 35 of the 51 cases, as assessed by diminution of the tumor mass and pain. Six deaths were attributed to the ^{90}Y treatments, and complications occurred in 11 other patients (in the skin in 5 cases, lung 4, intestine 3, brain 1, kidney 1, pharynx 1, and generalized 1). Motor nerve injury was observed in 2 cases. In one patient given ^{90}Y via the carotid artery, an immediate convulsive syndrome developed, followed by transient aphasia. Two patients given ^{90}Y via the aorta developed kidney damage and uremia. In 4 of 12 patients injected intravenously with ^{90}Y, uncontrollable pulmonary edema resulted and terminated fatally. Two other fatalities resulted from ileal occlusion after intra-aortic administration of ^{90}Y. Tracheotomy was required in another patient who developed pharyngeal edema after injection of ^{90}Y into the external carotid. Radiation-induced neuritis, with serious consequences, occurred in 2 cases. (BBB)

32714 RADIOTHERAPY. **Tudway, Robert C. (Bristol United Hospitals, Eng.). Med. Ann., 82: 355-62(1964).**

Injury from radiotherapy in children and adults and treatment of radiation sickness are briefly reviewed. In 17 children ranging in age from 10 days to 5 yr, who received x-ray therapy for Wilm's tumor, neuroblastoma, or medulloblastoma, the doses given varied from 2400 R in 3 weeks to 5100 R in 4 weeks. Two to 23 yr later the effects of the radiation on the spine were studied. Different degrees of affection of the spinal development were demonstrated, varying from a relatively mild change in the radiographic appearance of the vertebral bodies to a severe and gross affection. One patient who had been given 5000 R to the spine and survived for 17 yr exhibited a marked spinal deformity. Other patients who had less than 3000 R showed only minor effects. Other results are cited which indicate that in very young children a dose of 1500 R or above to the kidneys is dangerous. Effects in adults are also considered, particularly the damage to the intestine following radiotherapy for pelvic tumors in women. Bowel damage is more likely to occur when previous operation or sepsis has immobilized the bowel. (BBB)

32715 POSSIBLE VESICAL COMPLICATIONS AFTER RADIOTHERAPY OF FEMALE GENITAL CANCER. **Muller, J. H. (Kantonsspital, Zurich). Urol. Int., 21: 437-43(1966). (In French).**

A review is presented of the early effects and possible late complications in the bladder following radiation treatment of female genital cancer, which often yields excellent results. Both the frequency and severity of these complications are reduced by adequate planning and technical improvements in high-energy radiation therapy and by the early diagnosis and assiduous therapeutic care of urinary infection. Such complications may appear years after completion of radiotherapeutic cure and constitute a difficult diagnostic problem. One of the early, transient complications is bladder edema, having a neural origin, which may cause ureteral reflux and thus lead to retrograde urinary infections. It is important that radiotherapy not be instituted earlier than 3 to 6 weeks after a major operation in the pelvis. It was found that use of sulfonamides and, later, the combination of penicillin and streptomycin is most effective in preventing gynecologic infections after radiotherapy. Treatment of late complications of pelvic radiotherapy is also described. (BBB)

32716 STUDIES ON PANCREATIC SCANNING BY MEANS OF ^{75}Se-SELENOMETHIONINE. **Mizukami, Takahisa (Kurume Univ., Japan). Nippon Acta Radiol., 26: 1299-1313(Jan. 1967). (In Japanese).**

The metabolism of ^{75}Se labeled selenomethionine was studied in rabbits with particular attention to the pancreas. Uptake by the pancreas was at a maximum 30 to 50 minutes after injection. If this time interval is chosen for scanning the pancreas, the dose can be reduced to 2 μCi/kg. This method was used in scanning 45 cases of human pancreatic disease. Results are presented for pancreatic carcinoma, chronic pancreatitis, and pancreatolithiasis. The data indicate that ^{75}Se labeled selenomethionine can be used for the detection of pancreatic disease in man. (TSS)

32717 USE OF PARENTERAL CHEMICALS FOR PROTECTION AGAINST ORAL RADIATION DEATH IN MICE. **Goepp, Robert A.; Fitch, Frank W.; Doull, John (Univ. of Chicago). Radiat. Res., 31: 149-55(May 1967).**

Male C57Bl mice were given x radiation to the head in a manner that would produce oral radiation death. Preirradiation administration of MEA, AET, and PAPP, given intraperitoneally, increased the LD_{50} above that of irradiated control mice to produce an appreciable DRF, which was highest (1.33) with MEA. The maximum effect of radiation protection was found at 5 minutes postinjection for MEA and AET, and at 15 minutes for PAPP. It was also found that an increased dose of PAPP afforded more protection, and that the protective action of PAPP appeared to be independent of methemoglobinemia. Oxygen saturation of the tissues enhanced the protective ability of PAPP. The occurrence of delayed death in survivors of oral radiation death suggested the presence of another mode of head irradiation death previously obscured by oral radiation death. (auth)

32718 RADIATION RESPONSE OF MAMMALIAN CELLS GROWN IN CULTURE. VI. PROTEIN, DNA, AND RNA INHIBITION DURING THE REPAIR OF X-RAY DAMAGE. **Elkind, M. M.; Moses, W. B.; Sutton-Gilbert, H. (National Cancer Inst., Bethesda, Md.). Radiat. Res., 31: 156-73(May 1967).**

The effects of puromycin, high concentrations of thymidine, and actinomycin D on protein, deoxyribose, and ribose nucleic acid synthesis, respectively, were examined in connection with the repair of sublethal x ray damage of mammalian cells in tissue culture measured by the dose fractionation technique. Within limits set mainly by drug toxicity, it was found that neither puromycin nor thymidine affect repair, although actinomycin D at very low concentration (5×10^{-9} M) does. The degree of inhibition of synthesis produced by these drugs was: puromycin, ~60%; thymidine, close to 100%; and actinomycin D, 50%. However, the concentration of puromycin used (6.0 μg/ml) was found to inhibit RNA synthesis as effectively as a level of actinomycin D which had a pronounced effect on repair. Analyzed together with earlier results which showed that repair proceeds quite well at reduced temperatures and does not require oxygen, we propose that repair may be a passive (nonenzymatic) process involving deoxyribose nucleic acid in stereochemical relationship to its molecular environment. (auth)

32719 ASCORBIC ACID PROTECTION OF ESCHERICHIA COLI AGAINST RADIATION LETHALITY IN THE PRESENCE OF TETRACYCLINES AND OTHER RADIOSENSITIZERS. **Pittillo, Robert F.; Lucas, Mary B. (Southern Research Inst., Birmingham, Ala.). Radiat. Res., 31: 36-46(May 1967).**

Tetracycline, oxytetracycline, and chlortetracycline present

during irradiation have been found to sensitize Escherichia coli ATCC 9637 to the lethal action of ionizing irradiation. Ascorbic acid, which has no significant radiomodifying properties in E. coli, affords marked protection against radiation damage when present in the cell suspensions in the presence of the tetracycline antibiotics during irradiation. The mechanisms by which these compounds exert their radiomodifying effects are not known, although the data suggest possible interference with repair mechanisms. (auth)

32720 A ROTATIONAL TECHNIQUE FOR ASSESSING QUANTITY AND DISTRIBUTION OF BODY RADIOACTIVITY. Anderson, Jesse I.; Olson, Dale G. (Atomic Energy Commission, Idaho Falls, Idaho). Health Phys., 13: 719-32(July 1967).

A new whole-body counter is described that provides a method for the determination of the amount and distribution and radionuclides in the human body. The quantitative measurements are relatively independent of differences in the distribution of the radioactivity in the body or the anatomical differences of the individuals who receive the whole-body counts. The measurement is taken with the human subject rotating on a power-driven turntable while the scintillation detectors move down the longitudinal axis of the rotating body. The result of rotating the body with respect to the detector is the elimination of effects caused by changes in location of the radioactivity and the differences in the absorption; essentially the effects of these factors are averaged. Because sources of activity that are displaced from the axis of rotation in a revolving sample or human body produce oscillations in counting rate, the approximate location of the radionuclide can be determined at the time of the quantitative measurement. The position of the detector with respect to the different parts of the body can be defined as a point along an imaginary helix if the measurement is taken while the detector is moving down the longitudinal axis of the rotating body. The location of the radioactive source is indicated by increased counting rate at points along this helix which surrounds the body. Counting rate, linear distance of the detector down the body from a reference point, and body orientation with respect to the detector are the three variables for defining the position of activity. This technique of counting is especially applicable for the in vivo determination of radionuclides in human subjects because both the body radioactivity and approximate distribution can be determined simultaneously. In addition to whole-body counting, the combined rotation and scan technique also constitutes a method for the determination of activity in biological samples in which large volumes are required to obtain adequate sensitivity. The procedure can be used for any type of solid samples that contain an unknown distribution of activity. The density of the matrix material in which the activity is contained and the distribution of the activity in the sample are discussed as factors affecting absolute counting. Applicability of the method to in vivo whole-body counting has been confirmed by counting ^{131}I and ^{54}Mn at various locations inside a human volunteer. The maximum variation of counting rate for different positionings of the sources in the body was 400 and 19 percent for the static counting method,and the new rotation method, respectively. The counting sensitivity is comparable for the two methods if the volumes of scintillation detectors are equal. (auth)

32721 THERAPEUTICAL EFFECT OF ALUPENT AFTER LETHAL GAMMA-IRRADIATION. Gabler, E.; Stoeckl, W.; Casta, J. (Tieraerztliche Hochschule, Vienna. Reaktorzentrum, Seibersdorf, Austria). Atompraxis, 13: 188-9(Apr.-May 1967). (In German).

A 3.2 mg dose of Alupent given subcutaneously about 5 minutes after lethal γ-irradiation produced a survival rate of 72% in guinea pigs; 10.0 mg Alupent yielded a survival rate of 39% in albino rats. (auth)

32722 A COMPARATIVE STUDY OF ROENTGENOGRAPHIC TECHNIQUES FOR DETECTION OF CALCIUM PYROPHOSPHATE DIHYDRATE DEPOSITS (PSEUDOGOUT) IN HUMAN CARTILAGE. Parlee, Donald E.; Freundlich, Irwin M.; McCarty, Daniel J. Jr. (Hahnemann Medical Coll. and Hospital, Philadelphia). Amer. J. Roentgenol., Radium Therapy Nucl. Med., 99: 688-94(Mar. 1967).

Roentgenograms of 180 joints were made employing 4 different types of film in an attempt to define an optimum technique for the study of pseudogout. Using the factors described, medical no-screen and industrial AA film were found to be best. Pseudogout (articular chondrocalcinosis) is defined by the presence of the calcium pyrophosphate dihydrate crystal. It is suggested that the technique described here provides a more reliable roentgenographic method for the detection of calcium pyrophosphate dihydrate crystal deposits in cartilage. (auth)

32723 LATERAL LUNG SCANNING, ANATOMIC AND PHYSIOLOGIC CONSIDERATIONS. Surprenant, Edgar L. (Univ. of California, Los Angeles). Amer. J. Roentgenol., Radium Therapy Nucl. Med., 99: 533-42(Mar. 1967).

A lateral scan of the chest visualizes the lung closest to the detector. The lateral decubitus position permits maximum expansion of the superior (scanned) lung with little respiratory motion of its hemidiaphragm. The configuration of a lung scanned in a lateral projection approximates the shape of a mid-sagittal section through that lung. Prominent mediastinal structures may be outlined. Roentgenograms of the chest should be obtained with the subject in the scanning position; the hemidiaphragm of the scanned (superior) lung will usually be most caudal. The position of the subject during injection will influence the distribution of the macroaggregated radioalbumin except in subjects with increased pulmonary vascular pressure or flow. The lateral view permits visualization of posterior basal lung segments in subjects who are unable to lie prone for a posterior view. Small lesions not demonstrated in the anterior or posterior view may be detected in the lateral view. The lateral view permits better definition of the size and shape of lesions seen on the anterior or posterior view; frequently, the specific lung segment(s) involved by the pathologic process can be identified. (auth)

32724 A COMPARISON STUDY OF LARYNGOGRAPHY TECHNIQUES. 150 kVp PLAIN ROENTGENOGRAPHY VS POSITIVE CONTRAST ROENTGENOGRAPHY. Thornbury, John R.; Latourette, Howard B. (Univ. of Iowa, Iowa City). Amer. J. Roentgenol., Radium Therapy Nucl. Med., 99: 555-61(Mar. 1967).

In a series of 15 patients having laryngeal tumors, positive contrast laryngography was found to be superior to the 150 kv plain roentgenography in both tumor detection and delineation. However, the subglottic region was equally well visualized by both techniques. When positive contrast laryngography is technically unsatisfactory or contraindicated, 150 kv plain roentgenography offers an alternative method, especially as regards evaluation of subglottic involvement by tumor. (C.O.)

32725 SURGERY OF TUMORS OF THE SKIN. Conway, Herbert; Hugo, Norman E.; Tulenko, John F. Springfield, C. C Thomas, 1966. 381p. $14.00.

A chapter of this monograph is devoted to postirradiation dermatitis and malignancy, their incidence and treatment. The preferred treatment of radiodermatitis is surgical excision, but such treatment of skin and underlying tissues damaged by x-ray therapy is difficult. Tissues of the affected area are avascular and the soft tissue adjacent to the postirradiation dermatitis has a limited blood supply. After premature excision of injured areas, subsequent areas may become devitalized due to the progressive nature of the vascular response. As a result, regional flaps often cannot be used in repair because of their tendency to necrosis. Surgical treatment should consist of excision of the involved tissue down to a base with normal vascularity. Thick-split grafts of skin will be successful if the abnormal tissues have been excised completely. Because of the loss of subcutaneous tissue, a pedicled flap of skin and subcutaneous tissue is necessary if functional restoration is to be achieved. In a series of 100 cases 27 of the 40 patients with radiation dermatitis following treatment of benign conditions and 18 of the 60 patients with radiation dermatitis following treatment of malignant disease required surgical treatment. Of these 45 patients, it was necessary to employ flaps and pedicles for reconstruction in 24 cases. Among 63 other cases, 2 patients developed carcinoma in the area of radiodermatitis. Of the patients with radiodermatitis following radiation for benign lesions (hirsutism, acne vulgaris, wart, goiter, and psoriasis) 36.5% developed carcinoma. Nine developed multiple carcinomas. The average age on initial discovery of the malignancy was 51 yr. The average time from radiation therapy to development of carcinoma of the skin was 26.8 yr for basal cell carcinoma and 21.4 yr for squamous cell carcinomas. Various concepts on the cause of carcinoma arising in the scars of postirradiation dermatitis are discussed, including those relating to response to repair, direct effect of radiation on the epidermis, dermal changes, and lack of a feedback mechanism. (BBB)

Radiation Effects on Animals

Refer also to abstracts 32561, 32615, 32629, 32656, 32658, 32701, 32706, 32707, and 32818.

32726 (AECD-AG-20) THE SUSCEPTIBILITY OF THE RED FLOUR BEETLE, TRIBOLIUM CASTANEUM (HERBST.) TO GAMMA RADIATION. Bhuiya, Abdul Dayen; Matin, A. S. M. Abdul (Atomic Energy Centre, Dacca (Pakistan)). Mar. 1967. 22p. Dep.

An investigation was carried out to examine the γ radiosensitivity of the metamorphic stages of the red flour beetle, Tribolium castaneum (Herbst.) with regard to emergence and survival. Almost complete kill of adults, eggs, larvae, and pupae was obtained at doses of 25000, 9000, 8000, and 20000 R, respectively. The mini-

mal effective dose for control of T. castaneum was estimated to be 20000 R. Also, 8% of the sterilized adults survived the 20000 R dose. (B.H.S.)

32727 (AECD/RB-6) LABORATORY REARING AND SUSCEPTIBILITY OF THE CONFUSED FLOUR BEETLE (ADULT) TO GAMMA RADIATION. Hossain, M.; Hossain, M. M.; Rahman, R. (Atomic Energy Centre, Dacca (Pakistan)). Jan. 1967. 17p. Dep.

A method for mass rearing of the confused flour beetle, Tribolium confusum J. DuV, is described. The duration of each of the metamorphic stages of the insect was noted; the dispersion in the growth rate was found to be maximal in the embryonic stage and minimal in the larval stage. The susceptibility of the adult flour beetle to γ radiation was also investigated. It was found that 100% kill was possible within 13 days after the beetles were irradiated at a dose of 16 to 25 kR. (B.H.S.)

32728 (AED-C-04-26) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. STRAHLENWIRKUNG AUF LEBENDES GEWEBE UND ORGANISMEN. (Bibliographies in Nuclear Science and Technology. Radiation Effects on Living Tissues and Organisms). Stahlhofen, W. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Feb. 1967. 169p. (In German and English). Dep.

Titles of approximately 600 articles on radiation effects on living tissues and organisms appearing between 1964 and 1966 are compiled. (J.S.R.)

32729 (AED-C-04-28) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. STRAHLENWIRKUNG AUF LEBENDES GEWEBE UND ORGANISMEN. (Bibliographies in Nuclear Science and Technology. Radiation Effects on Living Tissues and Organisms). Stahlhofen, W. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Mar. 1967. 129p. (In German and English). Dep.

The titles of approximately 450 articles appearing from 1964 to 1966 on the effects of radiation on living tissues and organisms were compiled. The articles are obtained from conferences, dissertations, patents, reports, journals, and books. (J.S.R.)

32730 (ANS-SD-4) PROCEEDINGS OF THE SPECIAL SESSIONS ON RADIATION TRANSPORT AND BIOLOGICAL EFFECTS PRESENTED AT THE 1966 WINTER MEETING, PITTSBURGH, PENNSYLVANIA, NOVEMBER 1, 1966. Trubey, D. K. (ed.) (American Nuclear Society, Hinsdale, Ill.). 121p. (CONF-661125-Suppl.1). Dep. CFSTI.

Separate abstracts were prepared on 8 papers. Three papers were abstracted previously and appeared in NSA Vol. 20 as number 43580, Vol. 21 as number 16428, and as paper number 46 of conference 661001. (C.H.)

For abstracts of individual papers see: 32629–32634, 32731, and 32732.

32731 (ANS-SD-4, pp 79-81) DOSE AND DOSE-EFFECT RELATIONSHIP MODIFYING FACTORS IN PREDICTING THE DEGREE OF BIOLOGICAL RESPONSE. Bond, V. P. (Brookhaven National Lab., Upton, N. Y.).

Although absorbed dose in tissue is the cardinal parameter determining the degree of biological response, additional factors must be considered. These include principally the dose rate, the macro-distribution of energy deposition (depth-dose pattern), and the micro distribution of energy deposition (radiation quality, or LET). The relative importance of these factors will depend on the nature of the biological response under consideration (e.g., early effects of massive exposure such as mortality, or late effects such as leukemia production). Most accidental massive exposures occur over a period of seconds to hours; and in this dose rate range the dependence of biological effect on dose rate is slight. Likewise the RBE for high-LET radiations encountered, mainly neutrons, is close to unity at least for the bone marrow syndrome. The chief modifying factor for use in determining the early effects of massive exposure is then the degree of inhomogeneity of dose distribution on a macro scale. Non-homogeneous dose distribution can be taken into account as far as the bone marrow syndrome is concerned by means of a distribution effectiveness factor that is calculable on the basis of dose distribution, bone marrow stem cell distribution, and the marrow stem cell survival rate which is exponential with dose. With exposure protracted over months to years, long-term effects become of cardinal importance. Dose rate then becomes a major factor not only in regard to the expected degree of effect for low-LET radiations, but in determining the RBE of high-LET radiations as well. Although the integral dose per gram or the mean dose has no direct usefulness in predicting early mortality, it may be of value in determining the probability of cancer induction at least at relatively low values of total dose. If the cancer induction dose-effect curve is of the linear, no-threshold type, then the probability of cancer induction in an organ may be related to the mean dose per cell, $\Sigma m_i D_i / \Sigma m_i$, where m_i represents the mass of the cell i and D_i represents the absorbed dose to that cell and the expression is summed over the entire organ. This expression is conceptually equivalent to gram-rads/gram. There is evidence, however, that at least some net dose-cancer induction curves pass through a maximum at higher doses, perhaps as the result of interaction of the cancer-induction and a cell killing or other functions. In these dose regions the average dose would not represent a useful parameter for prediction of cancer rates. (auth)

32732 (ANS-SD-4, pp 91-5) CELLULAR AND MAMMALIAN RADIATION EFFECTS AND THEIR INTERPRETATION IN RELATION TO MANNED SPACE FLIGHT. Todd, Paul (Pennsylvania State Univ., University Park. Dept. of Biophysics).

Conditions encountered during space flight may modify the response of man to exposure to intermediate dose range radiation. Among the important early effects on man of radiation in this dose range are skin erythema, gastrointestinal response, and hematological depression. Factors that may modify the effects of radiation during space flight include acceleration, excitement, exercise, heat, cold, weightlessness, and vibration. The effects of radiation may, in turn, affect the biological response to these agents. Results are summarized from studies on the effects of space flight conditions on the effects of γ or x radiations on the reproductive capacity of human cells in tissue culture. Results of some animal studies on these same factors are also mentioned. (C.H.)

32733 (BNL-11477) LENS OPACIFICATION IN THE MOUSE; IMPLICATIONS FOR RBE AND QF. Bond, V. P. (Brookhaven National Lab., Upton, N. Y.). June 7, 1967. 23p. (CONF-670423-1). Dep. CFSTI.

From 2nd Panel on the Biophysical Aspects of Radiation Quality, Vienna, Austria.

Extensive data collected on lens opacification in the mouse exposed to x-rays established the following: An increased incidence of lens opacities was seen following even small doses; fractionation with a 12 hour interval between exposures decreased the degree of effect; the same total doses given at the rates of 2 or 100 rads/min. were equally effective; hypoxia did not significantly alter radiosensitivity; and hyperbaric oxygen appreciably increased radiosensitivity. Exposures to monoenergetic neutrons additionally demonstrated that: RBE values were relatively high; the values increased with decreasing neutron energy; the RBE increased appreciably with decreasing dose; and the values increased with decreasing dose rate, due to a rate dependence of effect with x-rays. The difficulties of extrapolating the data to QF values applicable for radiation protection are discussed; a possible approach to evaluating the significance of the data in this respect is presented. (auth)

32734 (CONF-661018, pp 213-19) SOME GUIDELINES FOR STUDIES INVOLVING INTERNAL ADMINISTRATION OF RADIOACTIVE MATERIALS TO HUMAN VOLUNTEERS. Sill, Claude W. (Idaho Operations Office (AEC), Idaho Falls. Health and Safety Div.).

Guidelines for studies involving internal administration of radioactive materials to human volunteers are outlined and discussed. The guide lines reflect the maximum quantity of radioactive materials that can be used only with good and sufficient justification. A general philosophy that the actual quantity to be used in any given experiment should not excede the smallest quantity necessary to achieve the intended results is stressed. (B.H.S.)

32735 (EUR-3270.d) PATHOGENESE GENETISCHER UND SOMATISCHER STRAHLENSCHAEDEN. Jahresbericht, 1965. (Pathogenesis of Genetic and Somatic Radiation Damage. Annual Report, 1965). (Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Biologie). Feb. 1967. 36p. (In German). Dep.

Studies of radiation effects on the frequency and cause of delayed somatic damage and genetic damage in animals are reported. The studies are intended to extend the scientific experience necessary for estimating the radiation hazard incurred from external radiation and from the incorporation of radioactive nuclides. The effects of low radiation doses were studied in particular. (auth)

32736 (EUR-3455.d) EXPERIMENTELLE UND KLINISCHE FORSCHUNGEN UEBER PHYSIOLOGIE, PATHOPHYSIOLOGIE UND STRAHLENPATHOLOGIE DER BLUTZELLBILDENDEN SYSTEME. I. PROLIFERATIONSKINETISCHE UND STRAHLENBIOLOGISCHE UNTERSUCHUNGEN UEBER DIE BLUTZELLBILDUNG. JAHRESBERICHT 1964–1965. (Experimental and

Clinical Research on the Physiology, Pathophysiology, and Radiopathology of the Hematopoietic Systems. I. Proliferation-Kinetic and Radiobiological Tests on Blood-Cell Formation. Annual Report, 1964–1965). Fliedner, T. M. (Gesellschaft fuer Strahlenforschung m.b.H., Freiburg (West Germany). Institut fuer Haematologie). May 1967. 62p. (In German). Dep.

The Annual Report of the Freiburg Research Team of the Euratom/GfS Association on research concerned with: Hematological diagnosis of radiation-induced hematopoietic disorders; the bases for therapeutic treatment of hematopoietic insufficiency; and tests on the physiology of blood-cell formation as a basis for the understanding of radiohematological findings is presented. The appearance and disappearance of atypical cells in the marrow and blood after a single irradiation was measured and related to the applied dose. The appearance and disappearance of atypical mitoses in the bone-marrow was studied in rats subjected to whole-body irradiations. The radiotoxicity of daily ^{3}H-thymidine injections over a period of six months was also studied. In connection with the study of persons exposed to radiations for many years, atypical hematological cells were found in thorotrast carriers. Thorough observations were made of the microbial flora and the effectiveness of thrombocyte transfusions on patients with hematological insufficiency and infections. As part of the study of the physiology of blood-cell formation, lymphocytes were investigated in man as regards their capacity to synthesize DNA and RNA. In particular, by retransfusion of lymphocytes marked in vitro with ^{3}H-cytidine, a method was developed that makes it possible to measure the circulating lymphocyte pool in man. In addition a study was made of the transformation capacity and nucleic acid synthesis of lymphocytes after stimulation with phytohemagglutinin and in vitro irradiation with x rays. (auth)

32737 (ORNL-P-3063) EFFECTS OF IONIZING RADIATION ON INTERSPECIFIC COMPETITION. Blaylock, B. G. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 22p. (CONF-670503-15). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

The effect of acute and chronic radiation on competition was studied in laboratory populations of the sibling species Drosophila melanogaster and Drosophila simulans that are similar both morphologically and genetically. Drosophila simulans was the superior species for thirty weeks in the control populations, but was eliminated by D. melanogaster when the populations were exposed to a chronic dose of 4.3 RADS/hr. After an acute dose of 2000 RADS, D. melanogaster was the superior species for approximately 12 weeks; however, the reverse was true when the populations were exposed to 10,000 RADS. Drosophila melanogaster was eliminated by D. simulans by the end of six weeks. The frequency of irradiated D. melanogaster or irradiated D. simulans (2000 RADS) decreased rapidly when placed in competition with non-irradiated flies of the opposite species. Under these conditions, irradiated D. melanogaster recovered after six weeks, but irradiated D. simulans never recovered and was eliminated in one population after 24 weeks. Population size was affected by the exposure to acute and chronic radiation, but most of the populations recovered after six weeks. The populations receiving 10,000 RADS were the exceptions; they required twelve weeks to recover. This was attributed to the effects of radiation on the reproductive capabilities of these species. After nine weeks of competition the populations having the largest average size were the ones that received an acute dose of 2000 RADS. (auth)

32738 (ORNL-P-3085) RELATIVE BIOLOGICAL EFFECTIVENESS OF GAMMA RAYS, X-RAYS, PROTONS, AND NEUTRONS FOR SPERMATOGONIAL KILLING. Oakberg, E. F. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 7p. (CONF-670305-5). Dep. CFSTI.

From Symposium on Biological Interpretation of Dose from Acceleration Produced Radiation, Berkeley, Calif.

Results of studies on spermatogonial killing in irradiated mice indicated that x rays, γ rays, and 130 as well as 730 MeV protons all appear to yield RBE's of 1. Neutron RBE's are a function of LET and dose, being greater with both low doses and higher LET. No simple relationship exists, however, between RBE and either dose or LET. (C.H.)

32739 (ORNL-P-3136) RADIATION AND CARCINOGENESIS. Upton, Arthur C. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 90p. (CONF-670709-1). Dep. CFSTI.

From Symposium on Peaceful Uses of Atomic Radiation, Rio de Janeiro, Brazil.

Salient information about radiation-induced cancer is briefly surveyed. Facts that throw new light on the role of radiation in carcinogenesis are reviewed. It was concluded from the review (205 references) that an association between irradiation and the occurrence neoplasms detected in human populations exposed to low levels of radiation existed. The dose-incidence relation could not be precisely specified for any neoplasm. Furthermore, the oncogenic effects of radiation appeared to depend on the age of the population at the time of exposure. The carcinogenic effects of radiation on animals appeared diverse and complex. The degree to which the process of carcinogenesis may involve indirect effects on the host, as well as direct effects on the tumor-forming cells themselves, could not be specified. In many instances, neoplasia apparently involved interactions among the effects of radiation, viruses, chemicals, and various host factors. (B.H.S.)

32740 (UR-49-744) ELECTROMAGNETIC-RADIATION-INDUCED PATHOPHYSIOLOGIC MODELS. Michaelson, Sol M. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). Mar. 17, 1967. Contract W-7401-eng-49. 5p. (CONF-670808-1). Dep. CFSTI.

From 7th International Conference on Medical and Biological Engineering, Stockholm, Sweden.

An effective biological model should be a representation of function as well as structure. Although physical models have been developed for many biological phenomena, functional simulation is not always feasible because of the complexity of living systems. The use of a living model for the study of biological interactions has the unique advantage of making a system available with a homeostatic capability which is the functional integration of the various organs and organ systems. The effects of electromagnetic radiation were studied in dogs exposed to 1000 kVp x rays, or 2800 MHz or 1280 MHz pulsed microwaves. Capillary-alveolar block, myocardial infarction, hypothyroidism, hypothalamic-hypophysial disturbance, and altered ferrokinetics are some of the manifestations of such exposures. Exposure to electromagnetic radiation provides a method for the study of the interactions of living organisms with external electromagnetic fields, and the role of such fields in the processes which go on in the internal milieu of the body. (auth)

32741 (USNRDL-TR-67-47) ANTIBODY PLAQUE-FORMING CELLS IN UNSENSITIZED MICE; SPECIFICITY AND RESPONSE TO NEONATAL THYMECTOMY, X IRRADIATION AND PHA. Hege, J. S.; Cole, L. J. (Naval Radiological Defense Lab., San Francisco, Calif.). May 1, 1967. 35p. CFSTI.

Using the standard antibody plaque technique, numbers of background anti-sheep erythrocyte plaque-forming cells (PFC's) in spleens of unsensitized mice were determined after neonatal thymectomy, after whole-body x irradiation, and after injection of phytohemagglutinin-M or typhoid paratyphoid vaccine. The results show that numbers of background PFC's are not affected by neonatal thymectomy or by whole-body x irradiation at dose levels known to inhibit cellular proliferation, but that they are significantly increased (10 to 20 fold) by phytohemagglutinin, typhoid vaccine, and other unrelated antigens. Simultaneous determinations of background anti-sheep erythrocyte and anti-horse erythrocyte PFC's indicate that these two populations are independent of one another. From these and other studies it is concluded that background PFC's produce specific hemolysin, are thymus independent, are relatively long lived (average lifetime >7 days), and are not related to the antigen sensitive precursors of the primary response PFC's. (auth)

32742 (N-67-13790) EFFECT OF IONIZING RADIATION OF THE FUNCTIONING OF THE VESTIBULAR ANALYZER. Moskovskaya, N. V. Translated from Vestn. Otorino-Laringol., 21: 59-62(1959). 12p. (NASA-TT-F-10498). CFSTI.

Studies on the function of the vestibular analyzer in patients subjected to the action of ionizing radiation are presented. Ionizing radiation increases the excitability of the function of the vestibular analyzer during radiation therapy, as well as after a lapse of 5 to 7 years following such therapy. The elevated functional excitability of the vestibular analyzer is apparently due to weakening of the inhibitory action of the cerebral cortex, which is substantiated by chloral hydrate tests. (STAR)

32743 THE TOXICOLOGY OF RADIOACTIVE SUBSTANCES. VOLUME 3. ^{89}Fe. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). Oxford, Pergamon Press, 1967. 190p. 55s.

Translated by R. E. Travers from Toksikologiya Radioaktivnykh Veshchestv.

Experimental results on animals obtained by the Radiotoxicology Laboratory of the Institute of Occupational Hygiene and Disease, Academy of Medical Sciences, USSR, are described. (UK)

32744 AN ATTEMPT TO QUANTITATE THE ERYTHROPOIETIN REPAIRING EFFECT ON THE BONE MARROW OF RATS EXPOSED TO 100 TO 600R OF X RAYS. Hajdukovic, S. (Inst. of Nuclear Sciences, Belgrade); Szirmai, E. Nucl. Energy, 83-8 (May-June 1967).

Rats were irradiated with 200, 400 and 600 R, and immediately

submitted to a blood loss of 40 to 50 per cent. Bleeding under these conditions was followed by very intense erythropoietin synthesis. The increased serum erythropoietin titer induced accelerated regeneration of erythroid bone marrow cells, but was without effect on myeloid cells. On the basis of this study the erythropoietin effect could be considered as the factor strengthening the repair processes of erythropoiesis in irradiated subjects. (UK)

32745 SUB-LETHAL AND LETHAL RADIATION DAMAGE. Elkind, M. M.; Sutton-Gilbert, H.; Moses, W. B.; Kamper, C. (National Cancer Inst., Bethesda, Md.). Nature (London), 214: 1088-92(June 10, 1967).

Treatment of x-irradiated Chinese hamster cells with actinomycin D points to similarities in the repair of lethal and sub-lethal injuries, which suggests that the two kinds of damage may be qualitatively equivalent. (auth) (UK)

32746 SPECTRA OF MITOGENETIC RADIATION OF MUSCLES AS AN INDICATION OF THE DYNAMIC MOLECULAR ORGANIZATION OF SARCOPLASMA. Gurvich, A. A. (Inst. of Normal and Pathologic Physiology, Moscow). Byull. Eksp. Biol. Med., 62: No. 8, 53-6(Aug. 1966). (In Russian).

Data are presented on spectral analysis of mitogenetic radiation in the frog and rabbit gastrocnemius muscle in vivo. The width of spectral bands under normal conditions is shown, as well as the appearance of narrower bands in reduction of general metabolism. Detailed analysis confirms previous tentative data on age changes in the spectrum. The gradual widening of spectral bands and lessening of their number indicating the appearance of the molecular orderliness of the sarcomplasma occur simultaneously with the formation of muscle innervation. (auth)

32747 RADIOTHERAPY IN LOCALLY ADVANCED CANCER OF THE BREAST: ADJUNCT TO STANDARD THERAPY. Guttmann, Ruth (Francis Delafield Hospital, New York. Columbia Univ., New York). Cancer, 20: 1046-50(July 1967).

Radiotherapy in inoperable hopelessly advanced carcinoma of the breast kept 25 to 30% of the patients alive and comfortable for five years. When, on the other hand, radiotherapy was used as the exclusive treatment in clinically operable carcinoma of the breast with microscopically proved distant lymph node metastases, the five-year survival of these patients was 60%. Postoperative radiotherapy, as reported in the literature, has added 5 to 10% to the patients' five-year survival, a figure which cannot be considered insignificant, in spite of contradictory quotations. The facts therefore verify the clinical findings and observations that irradiation, especially with megavolt units, has an undisputable place in the management of patients with carcinoma of the breast as well as the primary treatment and as an adjunct to surgery. (auth)

32748 INFLUENCE OF SYMPATHECTOMY ON THE RADIOSENSITIVITY OF NORMAL TISSUES. Kirov, S. (Scientific-Research Oncology Inst., Sofia). Med. Radiol., 12: No. 6, 69-72 (June 1967). (In Russian).

The author has practiced since 1952 bilateral ligature of the external carotid arteries to reduce the radiosensitivity of normal tissues. As sympathectomy was performed when arteries had been ligated it was necessary to investigate the influence of this operation on the radiosensitivity of tissues. Experiments on rabbit's ears demonstrated enhanced radiosensitivity of its tissues when sympathectomy was previousaly performed. Combination of ligature of the external carotid artery with homolateral sympathectomy did not alter significantly the radiosensitivity of the rabbit's ear tissues. (tr-auth)

32749 EFFECT OF WHOLE-BODY IRRADIATION ON THE PROTEOLYTIC ACTIVITY IN RABBIT LEUKOCYTES. Kopitar, Majda; Lebez, Drago (Josef Stefan Nuclear Inst., Ljubljana, Yugoslavia). Strahlentherapie, 133: 132-6(May 1967).

Catheptic activity of leukocytes and white blood picture was followed in rabbits. The effect of 40 R of whole-body γ radiation on the rabbits was studied within 48 hour after exposure; sham-irradiated samples were observed as well. An increase in activity was demonstrated in irradiated samples. There was no correlation between changes in the total and differential leukocyte count and catheptic activity after irradiation. (auth)

32750 ELECTRON-MICROSCOPIC INVESTIGATION ON THE LIVER AND KIDNEYS OF MICE AFTER INTRAPERITONEAL ADMINISTRATION OF ^{198}Au. Morgenroth, Konrad Jr.; Verhagen, August (Univ., Muenster, Ger. Evangelische Krankenhauses, Plettenberg, Ger.). Strahlentherapie, 133: 74-85(May 1967). (In German).

Electron microscopic studies of the liver and kidney of mice were done after intraperitoneal administration of colloidal ^{198}Au. A time dependent vacuolar degeneration of the mitochondria and a baggy dilatation of the endoplasmatic reticulum was found in liver parenchyma cells and in the tubular epithelium of the kidney. The changes were observed continuously until necrosis of the cell occurred. Type and course of the change were compared with changes observed after x irradiation; no differences could be found. The ^{198}Au particles stored in the liver could be identified in histological sections without later contrast measures and the form of the storage could be observed. Colloidal gold-198 could not be found in the kidney. (auth)

32751 REPORT ON THE LATE CHANGES IN RAT LIVER AFTER WHOLE-BODY AND LOCAL IRRADIATIONS. Weseloh, Gerd; Nikfetrat, Ali; Gregl, Anton; Eger, Wilhelm (Univ., Goettingen, Ger.). Strahlentherapie, 133: 86-101(May 1967). (In German).

After whole-body x-irradiation with 600 R or 800 R and a local irradiation with 3000 R, the death of rats during the early as well as the late stages was accompanied, in most cases, on severe degenerative and necrotic liver changes that indicated the breakdown of liver function. It was concluded from these and previous results that the liver was a radiosensitive organ but that by its great functional and structural compensation power was able to cope with the consequences of a radiation insult. Morphological and metabolic disturbances become obvious only when the compensation power of the liver cell or the cell complex was exhausted. (auth)

32752 RADIATION INJURIES TO THE RETICULO-ENDOTHELIAL SYSTEM OF THYMECTOMIZED MICE. Fridrich, Raimund (Univ., Basel). Strahlentherapie, 133: 63-7(May 1967). (In German).

Gamma irradiation of the liver of mice with 1000 or 2000 R caused a reduction in the phagocytic activity of the Kupffer cells. The result was a lower ^{198}Au storage in the liver; while the spleen stored more accordingly. On the contrary, splenectomy caused an increased ^{198}Au storage in the liver. This correlation between the histiocyte elements of liver and spleen was not influenced by the thymus and was an additional indication for the divergent behavior of immune reactions and phagocytosis after thymectomy. (auth)

32753 CRITICAL CONSIDERATIONS ON EMPLOYING SCATTERERS WITH ELECTRON BEAMS ACCELERATED BY THE BETATRON. Cova, Pier Luigi; Botti, Giorgio; Tosi, Giampiero (St. Ambrogio Clinic, Milan). Strahlentherapie, 133: 7-12(May 1967).

Inspection of skin reactions, during eight years of application of the electron beam from a 32 MeV BBC Betatron, revealed peculiar trends in precocious and late reactions, caused by inhomogeneous irradiation field. A follow-up of several years disclosed that the pattern of dischromy and achromy zones of the irradiated skin perfectly matched, with the characters of topographic biological reproduction, thepattern of isodose curves. Among the physical factors influencing the homogeneity of the Betatron's fields of irradiation, there predominate the arrangements to widen and homogenize the beam of accelerated electrons. After recalling the theoretically ideal system of utilizing the focusing properties of magnetic lenses, as well as the shortcomings involved in practical application, an analysis was made of a few problems caused by the scatterers actually employed in Betatrons for clinical application. (auth)

32754 INFLUENCE OF UV RADIATION ON THE BODY DEFENSE WITH SPECIAL REGARD FOR THE PROPERDIN SYSTEM. Pfordte, Klaus; Ponsold, Werner (Martin-Luther-Univ., Halle, Ger.). Strahlentherapie, 133: 149-57(May 1967). (In German).

After surveying the relationships existing between properdin, uv-irradiation, and nonspecific humoral resistance, recent results dealing with these problems in humans and rabbits are reported. A single irradiation with the total spectrum of a high pressure Hg-burner increased significantly the level of serum properdin. Irradiations administered repeatedly in short time intervals (twice weekly) caused no progressive increase of the properdin titer. After passing through a maximum (as achieved after a single irradiation), the properdin level reached a minimum (63% of the initial value) after 10 days. It was assumed that the stimulation of the properdin synthesis by a single uv-irradiation was connected with the known increase of blood bacteriocides. The importance of the uv-rays for the prophylactic increase of the nonspecific humoral resistance is discussed. (auth)

32755 STUDIES ON AN EXPERIMENTAL POPULATION OF DROSOPHILA MELANOGASTER RAISED ON IRRADIATED BANANA DIET. Hossain, M. M.; Mollah, M. S. Alam; Malik, M. U. (Atomic Energy Centre, Dacca). Food Irradiat., 7: No. 3, 45-9(Jan.–Mar. 1967). (AECD-RB-4).

Seven generations of Drosophila melanogaster were fed irradiated banana diet. Banana treated with 35000 rad, 45000 rad, and 55000 rad was compared with untreated banana for effect on egg-pupae ratio, percent adult emergence, longevity, egg-produc-

tion and viability in order to assess possible toxicity or changes in nutritive value or mutagenic effects. No effects were found that could be attributed to irradiated food. (auth)

32756 COMPARATIVE STUDY OF THE RADIOSENSITIVITY AT DIFFERENT STAGES OF OOGENESIS. Tikhomirova, M. M. (Leningrad Univ.). Genetika, No. 6, 24-32(June 1967). (In Russian).

It was shown by a comparative study of the radiosensitivity at the different stages of oogenesis of Drosophila, carried out by means of the comparison of the frequency of the cases of X-chromosome loss as the result of breaks, that at least three groups of cells could be distinguished: the most radiosensitive 14-stage oocytes; the less sensitive early oocytes at other stages; and the nonsensitive oogonia. The potential damages in the 14-stage oocytes were shown to be repaired under normal conditions. The course of the repair was not uniform; thus most damages were repaired during the first 30 minutes after the irradiation, but some persisted for more than an hour. During the period of 0.5 to 8.5 hours after the irradiation the aftereffect was proportional to the duration of the exposure to high temperature: i.e., the realization of the potential damages under high temperature was uniform in character. In early oocytes (7 to 13 stages) the after-effect of radiation could be detected only after a long period (8 hours) of temperature treatment, which was indicative of their higher reparative ability as compared to the 14-stage oocytes, and of the similarity of breaks (with respect to the duration of the time during which they remained open) at these stages. No perceptible aftereffect of radiation was observed in oogonia which was probably associated with the elimination of the damaged oogonia during the meiosis. The study of the x radiosensitivity by means of the comparison of the frequency of the non-disjunction of X-chromosomes revealed no differential sensitivity of gametes in oogenesis. (auth)

32757 EFFECTS OF WHOLE-BODY X IRRADIATION ON ENZYMATIC ACTIVITY OF SERUM, LIVER, AND SPLEEN OF RATS. Tittobello, A.; Stabilini, R.; Casolo, F.; Zanolla, W. R.; Vergani, C. (Univ., Milan. Univ., Padua). Radiobiol. Radioter. Fis. Med., 22: 3-10(Jan.-Feb. 1967). (In Italian).

Data are given that pertain to the quantitative dosage of lactate dehydrogenase as well as to its electrophoretic characteristics in the serum, liver, and spleen of rats that were exposed to whole-body x radiation at a dose of 800 R. The controls carried out during the lapse of time from 5 to 10 minutes showed differences in enzymatic levels and electrophoretic pattern. The differences are discussed. (auth)

32758 RADIOSENSITIVITY OF GERM CELLS. Mandl, Anita M. (Univ. of Birmingham, Eng.). Biol. Rev. Cambridge Phil. Soc., 39: 288-371(Aug. 1964).

A review (450 references) that considered the biochemical morphological, functional, and genetic criteria used in the determination of germ cell radiosensitivity as well as the various chemical and physical factors that influence the radiosensitivity is presented. It was concluded that the radiosensitivity of germ cells depended on the stage of development at the time of irradiation and the criterion by which the radiosensitivity was assessed. (TSS)

32759 BERYLLIUM INDUCED SARCOMAS OF THE RABBIT TIBIA. Tapp, E. (Univ. of Manchester, Eng.). Brit. J. Cancer, 20: 778-83(Dec. 1966).

A simple method of inducing bone sarcomas in rabbits by a single intramedullary injection of zinc beryllium silicate is described. The radiological, morbid anatomical, and histological features of four sarcomas produced by this method are presented. The earliest radiological change was an area of increased radiodensity at the site of injection. All four tumors metastasised to the lungs, and in some cases metastases were found in the parietal pleura and hilar lymph nodes. Histologically the tumors had a varied appearance and resembled bone sarcomas found in man. (auth)

32760 CHANGES IN THE MYOCARDIUM IN A COMBINATION OF ORTHOSTASIS AND IRRADIATION IN RABBITS. Ariel, B. M. Arkh. Pathol., 29: No. 5, 34-8(1967). (In Russian).

Myocardial necroses were reproduced in 50 rabbits on the 5th or 14th day after whole-body x irradiation (800 R) by placing the animals in vertical position (orthostasis). Evolution of inflammatory changes of the myocardium was traced for 30 days after orthostasis. Extensive affections of the myocardium, chiefly in the right ventricle and the right half of the interventricular septum were observed. Peculiar types of alterative lesions of the muscle fibers, their vacuolization and lysis, along with grave affections of the interstitial tissue, extensive diffuse edema, mucoid swelling, and fibrinoid necrosis of the collagen fibers, constituted qualitative peculiarities of the inflammatory process. Early, rapidly progressing sclerotic changes were evidently independent of fibroplastic function of fibroblasts, developing according to primary sclerosis type as a sequence of marked edema. (auth)

32761 PATHOGENESIS OF FOAM CELL LESIONS IN IRRADIATED ARTERIES. Kirkpatrick, Joel B. (John Cochran Veterans Administration Hospital, St. Louis. Washington Univ., St. Louis). Amer. J. Pathol., 50: 291-309(Feb. 1967).

Foam cell lesions similar to those observed in the blood vessels of irradiated tissues in man were reproduced in the ear arteries of rabbits by combining local x irradiation and hyperlipemia. Early changes were present at 16 to 18 days following irradiation and lesions were well developed at 9 weeks. They developed after any dosage of x rays from 500 to 4,000 R. The foam cell lesion has been identified ultrastructurally as a form of atherosclerosis. It is not specifically a result of irradiation injury since it can be induced by various types of local injury in hyperlipemic animals. Fibrous plaques were formed in irradiated vessels if the animal had normal serum lipids. (auth)

32762 RAISING THE RADIOSENSITIVITY OF THE NERVOUS SYSTEM WITH THE AID OF FERMENT POISONS EVOKING DISTURBANCE OF OXIDATIVE PROCESSES. Minaev, P. F.; Kantorova, V. I.; Logvinova, O. F.; Mironova, A. P.; Chukhova, A. I. (Inst. of Biophysics, Moscow). Ukr. Biokhim. Zh., 39: 179-91 (1967). (In Russian).

The oxidative processes and radiosensitivity of nervous tissue under the effects of sodium arsenate, monofluoracetate, and monoiodoacetate separately and in combination with local x-ray irradiation of the cerebellum were studied in dogs. The results were estimated by the content of pyruvic, citric, and gamma-aminobutyric acids; the state of the oxidative phosphorylation process in the mitochondria; the changes in the cerebellum nerve cell structure; and the clinical state of the animals. It was shown that preliminary introduction of substances blocking various links of oxidative processes in brain tissue leads to a considerable rise in the radiosensitivity of the nervous system on subsequent local irradiation. This is confirmed by the results of previous research, which indicate that the radiosensitivity of the nervous system is conditioned by its oxidative processes. (auth)

32763 FECUNDITY, FERTILITY, AND RECOVERY OF GERMINAL TISSUE OF PHYSA ACUTA EXPOSED TO ACUTE DOSES OF X RAYS. Ravera, Oscar; Mariani, Graziella (EURATOM-CCR, Ispra, Italy). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 41: 380-5(Nov. 1966). (In Italian).

Adults of the marine snail, Physa acuta, were exposed to the following doses of x rays: 2, 4, 6, 8, and 10 kR at 200 R/min. The values of mortality, fecundity, and fertility of the adults and those of viability of the embryos were recorded for 160 days after irradiation. Results indicated that the mean length of adult life and of fecundity period was not reduced by doses until 10 kR; fecundity, fertility, and viability rates were reduced also by doses as low as 2 kR; and recovery of germ tissue was evident for individuals exposed to doses ranging from 2 to 10 kR. (auth)

32764 ACTION OF CHEMICAL RADIOPROTECTORS ON THE HYPOTHALMIC NEUROSECRETION OF RATS EXPOSED TO IONIZING RADIATION. Duchesne, P. Y.; Hajdukovic, S. (Univ., Liege). Compt. Rend. Soc. Biol., 160: 2207-8(1966). (In French).

The administration of chemical radioprotectors such as cysteamine or cystamine caused an increased secretion of pituitary hormones in x-irradiated rats. This phenomenon is normally produced only several hours after irradiation. The increased pituitary hormone secretion enabled the rats to react immediately to the stress of irradiation. (tr-auth)

32765 COMPARATIVE RADIOSENSITIVITY OF MALE MICE AND HAMSTERS. Leonard, A.; Deknudt, G. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Compt. Rend. Soc. Biol., 160: 2209-11(1966). (In French).

The weight decrease of testicles after an acute dose of x radiation does not appear to be sufficient criteria to estimate the histological damage in these organs. If this weight decrease reflects very accurately the disappearance of reproducing cells, it does not permit at all the presumption of the regeneration of the seminal epithelium. The x ray dose required to kill 100% of male hamsters in 30 days is much higher than in the mice, whereas the testicles of hamsters are much more radiosensitive. There does not seem to be a direct relation between the general radiosensitivity of an individual and the radiosensitivity of the gonads. (tr-auth)

32766 SPECTROPHOTOMETRIC STUDIES OF THE POST-IRRADIATION CONTENT OF CYTOPLASMIC RIBONUCLEIC ACID IN EPITHELIAL CELLS OF RAT CRYSTALLINE LENS. Busti, A.; Sorrentino, R.; Tognacca, M. L. (Ospedale Maggiore, Novara, Italy). Radiobiol. Lat., 7: 75-82(1964). (In Italian).

By means of a quantitative spectrophotometric method, a study of the post-irradiation changes of ribonucleic acid (RNA) in the epithelial cells of the equatorial and of the polar zone of the lens in rats exposed to direct irradiation of the eye was carried out using a contact-irradiation apparatus. The animals were treated with doses of 1500 and 3000 R in a single application, and were killed 10 minutes, 6 hours, 24 hours, and 7 days after the treatment. Both types of cells showed a decrease in the quantity of cytoplasmatic RNA, within 10 minutes after the irradiation; this decrease was more pronounced in the animals treated with 3000 R. Subsequently, the quantity of cytoplasmatic RNA gradually increased again. (auth)

32767 USE OF PROBIT ANALYSIS TO ESTIMATE DOSE EFFECTS ON POSTIRRADIATION LEUKOCYTE DEPRESSIONS. Rosenblatt, L. S.; Goldman, M. (Univ. of California, Davis). Health Phys., 13: 795-8(July 1967).

In the quantitation of radiation effectiveness it is frequently useful to compute the median lethal dose (LD_{50}) to the populations studied by use of probit analysis. Preliminary statistical analysis of postirradiation leukocyte depressions in ^{226}Ra injected beagles indicated that the observed losses were dose-related. Analysis by a power function model was considered, as was the exponential model of in vitro cell survival following irradiation. The shape of the leukocyte response curve, however, appeared to be sigmoid, which suggested that probit analysis might be applicable. An example of the use of probit analysis on hematological data in terms of a specific probability model is presented, together with some suggestions of further applicability of this technique. (auth)

32768 SOME ASPECTS ON THE EFFECT OF X IRRADIATION ON INBRED MOUSE EMBRYOS. Shoji, Ryujiro; Ohzu, Eiji (Hokkaido Univ., Sapporo). Annot. Zool. Jap., 39: 179-84(Dec. 1966).

Inbred mouse embryos from MT and Swiss-albino strains were irradiated with 50 R, 100 R, and 200 R of x rays at 8.5 days postconception. The frequencies of abnormal and dead fetuses in irradiated mice were compared with those of untreated control specimens. Results showed that resorbed fetuses of MT mice increased significantly in frequency value in unirradiated animals; anomalies were observed to be considerably different between Swiss-albinos and MT mice in control as well as in irradiated groups; and the frequency of abnormal fetuses induced by irradiation increased in MT mice over the control value, whereas no such trend occurred in Swiss-albinos. On the basis of the above findings, it was concluded that the increased incidence of anomalies may not be due to a direct effect of irradiation, but is secondarily dependent on an alteration of the intra-uterine environment by x rays, while a high incidence of resorbed fetuses in irradiated MT mice may probably be attributed to a primary irradiation effect. (NSA of Japan)

32769 INFLUENCE OF X RAYS ON THE MITOTIC CAPACITY OF THE EPIDERMAL CELL. EXPERIENCES ON THE GUINEA PIG NIPPLE. Maggiora, A. (Univ., Geneva). Minerva Dermatol., 41: 119-22(Apr. 1966). (In Italian).

The great sensitivity of the guinea pig nipple was made on the basis of a test which can detect radiation effects at doses lower than those which produce histologic effects in ordinary skin. Male guinea pigs were treated topically with estrogen (50 μg/ml) at 5 to 45 days after irradiation with 800 R of soft (50-KV) x rays. Mitosis was blocked 9 hr later by application of colchicine (50 μg) to the nipple. The number of mitotic figures per field was 2.86 at 5 days, 3.14 at 25 days, and 4.33 at 45 days after irradiation, there being a significant difference between the 1st and 3rd and between the 2nd and 3rd values. In other experiments 2 doses of 800 R each were given to the male guinea pig nipple 20 to 40 days apart. By the estrogen-colchicine technique (estrogen applied 6 days after irradiation), the effect of the 1st irradiation was still evident after the 2nd one as seen by mitotic activity. Thus only about ½ the number of mitotic figures was seen after the 2nd irradiation as compared with after the 1st irradiation 20 days earlier. (BBB)

32770 USE OF RADIOACTIVE ISOTOPES AND IONIZING RADIATIONS IN ENTOMOLOGY. Robredo, Fernando (Servicio de Plagas Forestales, Madrid). Bol. Serv. Plagas Forest., 7: No. 13, 42-51(1964). (In Spanish).

Use of radiation in controlling insect pests is surveyed. A brief review on the methods of labeling insects with radioisotopes is given, as well as examples showing how radioisotopes have been of value in studying the dispersal and movement, life history, and behavior of insects. Ecological studies on food chains, nutrition cycles, and population dynamics have been carried out on radioisotope-tagged insects. Application of the first method, exemplified by work on Callitroga hominivorax, is limited to very few species by several biological requirements. Direct treatment could have wider application for the control of all species infesting stored food products. The most favorable products for radiation disinfestation are those handled in bulk such as grain. Some fundamental and applied problems in using radiation for this purpose are discussed and the relative merits of chemical fumigation and irradiation methods are compared. Radiation induces dominant lethal mutations in sperm; therefore, monogamy is not requisite for eradicating a population through the introduction of irradiated males. Possible effects on populations of release of males containing recessive lethal mutations are discussed, and the possibility of genetic induction of population extinction is explored. (BBB)

32771 THE PULMONARY RESPONSE OF RATS TO FLUORSPAR DUST AND RADIATION. de Villiers, A. J.; Gross, P. (Dept. of National Health and Welfare, Ottawa). pp 135-40 of Proceedings of Second International Symposium on Inhaled Particles and Vapours, Cambridge, Sept. 28th to Oct. 1st 1965. Oxford, Pergamon Press, 1967.

In the experiments described calcium fluoride (fluorspar) injected intratracheally in adequate dosage caused no significant pulmonary fibrosis and behaved as a so-called inert dust. X-irradiation of the chest in rats at the dosages used produced relatively slight collagenization of alveolar walls, several mouse-type adenomata and an adenocarcinoma within one year following irradiation. No inhibition of alveolar clearance was demonstrable under the conditions of the experiments, and when the lung dust burden was imposed six weeks following the irradiation. The failure of the x-irradiation to affect the alveolar clearance mechanism is attributed to the timing of the dust-burden imposition, a time when the alveolar lining had recovered from the radiation effects. A greater degree of alveolar fibrosis in the radiation-plus-dust animals than in the other groups was observed. Additive or adjuvant factors require further study. A high incidence of endemic chronic broncho-pulmonary disease was observed among dusted animals, whereas none was found in stock controls or in animals exposed to radiation only. (auth)

32772 ANTIBODY PRODUCTION BY CLONED CELL POPULATIONS. Feldman, M.; Mekori, T. (Weizmann Inst. of Science, Rehovoth, Israel). Immunology, 10: 149-60(Feb. 1966).

A method for the intrasplenic cloning of lymph node cells, based on the injection into x-irradiated recipients of cells from phytohemagglutinin-treated donors, was developed. Clones were tested for their capacity to form anti-Shigella antibodies and to produce a graft-vs-host immune response. It was found that each of the randomly chosen clones produced antibodies to Shigella. When immunized cloned cell populations were injected into secondary recipients, and the latter were again immunized with Shigella, an increased response was obtained. Clones produced by bone marrow cells in spleens of x-irradiated animals, similarly tested for the immunological competence, did not produce antibodies to Shigella. Cells of lymphoid clones of parental strain origin produced a graft-vs-host response in newborn F_1 hybrids. Bone marrow derived clones did not. Thus, each cloned cell population appears to be a priori pluripotential with respect to antibody formation. The immunological findings, analyzed in relation to the population sizes of the tested clones, indicated that each immune competent cell may, in fact, be pluripotential. (BBB)

32773 EXAMINATION OF THE PYRUVIC ACID CONTENT IN BLOOD-SERUM IN PATIENTS TREATED WITH RADIOTHERAPY. Kwasniewska-Rokicinska, Cecylia (Instytutu Onkologii, Gliwice, Poland). Pol. Przegl. Radiol. Med. Nuklearnej, 31: 297-304(Mar.-Apr. 1967). (In Polish).

The levels of pyruvic acid were estimated in blood of patients following radiotherapy of malignant neoplasms of the female genital organs. A significant increase of these metabolite levels was noted in the course of radiotherapy. (tr-auth)

32774 INCREASED SENSITIVITY OF CHICK EMBRYOS TO RADIATION AFTER INJECTION OF INK OR CHARCOAL. Zoeller, Wolfgang W. (Univ., Bonn. Kernforschungsanlage, Juelich, Ger.). Atompraxis, 13: 193-5(Apr.-May 1967). (In German).

A combination of X-irradiation of the extraembryonic blood with injection of ink or charcoal led to death in chick embryos, whereas the same irradiation without injection was not lethal. Results were explained as an inhibition of a defense mechanism with which the embryo was normally able to neutralize radiotoxins in the blood. (auth)

32775 MEASUREMENT AND CALCULATION OF RECOVERY PROCESSES IN NERVE MEMBRANE AFTER X-IRRADIATION. Vanselow, Kurt (Univ., Kiel). Atompraxis, 13: 195-9(Apr.-May 1967). (In German).

The stimulation threshold of the peripheral nerve fibers was lowered by x irradiation. Following irradiation, the threshold returned to normal. Measurements revealed an exponential return, the half-life value of which increased with an increase in the total dose. Changes in the stimulation threshold during irradiation were calculated mathematically. The hit area for the

fluid surrounding the membrane was calculated from the measurement results. (auth)

32776 EFFECTS OF OHP ON DYNAMICS OF CELL REPLICATION AND THE CALCULATION OF OXYGEN EFFECT FACTORS FOR X-RADIATION IN VITRO. van den Brenk, H. A. S.; Sparrow, Nancy (Cancer Inst. Board, Melbourne). pp 635-42 of Proc. Third Intern. Conf. Hyperbaric Med., Durham, N. C., Nov. 17 to 20, 1965. Washington, National Academy of Sciences, 1966.

Preliminary results obtained with irradiation of ELD Ehrlich ascites tumor cells in vitro in oxygen at high pressure (OHP) (5 atm) and in pure nitrogen at 1 atm are described. The oxygen enhancement factor (E) for x rays varied from 2.3 to 4.6 for different postinoculation times. This variation may have been largely due to the fact that E was lowest for cells in the presynthetic (G_1) phase of replication and highest in the late synthesis (S) phase and the postsynthetic (G_2) phase. A short OHP treatment in the absence of irradiation did not cause chromosome aberrations but did cause differential changes in the kinetics of cell replication. They consisted of an increase in rate of DNA synthesis during S phase (particularly in the slower-labeling compartments), and an inhibition of mitotic rate attributed to more rapid entry of cells from S to G_2 phase and arrest in G_2 phase, and delay in the transition of cells from G_2 to M. It is suggested that metabolic events during the G_2 phase may be largely glycolytic in ELD Ehrlich cells and associated with a low redox potential and an accumulation of reducing substances (e.g., SH groups), with a transition to aerobic metabolism and an oxidative state, setting in just prior to mitosis. This arrest in G_2 produced by OHP may thus be related to auto-oxidative changes, changes which can be largely reversed to shorten G_2 time by a short postoxygen exposure of cells to anoxic conditions. The higher oxygen effect ratio for cells in S–G_2 phase may possibly have clinical significance in irradiation of tumors during hyperbaric oxygenation on the basis of their greater radiosensitivity. (BBB)

32777 STUDIES ON MECHANISMS CONTROLLING THE IMMUNOGLOBULIN COMPONENTS OF THE IMMUNE RESPONSE. Smith, R. T.; Robbins, J. B. (Univ. of Florida, Gainesville). pp 381-95 of Molecular and Cellular Basis of Antibody Formation, Proceedings of a Symposium, Prague, June 1 to 15, 1964. New York, Academic Press, 1965.

To investigate the hypothesis which might explain the defect in the immature immune response in newborn animals that a deficiency of immunologically competent cells exists in neonatal life, an experimental model was developed in which the lymphoid tissue of an adult lethally irradiated rabbit is selectively restored by nonirradiated autologous cells. The nature of its response to a bacterial and a soluble protein antigen in these circumstances was determined. The data reported show that supralethal irradiation with shielding has a selective effect on the pattern of immunoglobulin response to a bacterial antigen and permits induction of tolerance to soluble proteins. In preliminary experiments it was found that up to 400-R whole-body irradiation did not suppress any component of the immune response; indeed, the total response was enhanced significantly in most animals. Supralethal levels of irradiation (800 and 1000 R) suppressed immunity to Salmonella antigen nearly completely, but small amounts of antibody, exclusively macroglobulin in character, were detected. Shielding experiments were therefore devised to examine the type of antibody formed by a limited population of nonirradiated cells. The whole spleen or its component cells, the appendix, whole peripheral blood, and a hind limb were shielded during irradiation. The findings supported the hypothesis that γ_{1M}-globulin antibody synthesis does not require the same process of cell differentiation in immunologically competent cells that γ_2-globulin synthesis does; the latter proceeds only after cell division has occurred. Such a hypothesis is consistent with experiments which indicated that injection of tissue exposed to x radiation resulted in a delayed synthesis of γ_2-globulin, whereas, injection of shielded tissue provoked a normal response simultaneously within a single animal. In adult animals, cells with the potential of synthesizing γ_{1M}-antibody were evidently present in the spleen, appendix, leg, and peripheral blood. (BBB)

32778 A STUDY OF THE COMPARATIVE EFFECTS OF IONIZING RADIATION AND AGING ON THE MAMMALIAN LENS OF THE EYE. Ham, W. T. Jr.; Geeraets, W. J.; Cleary, S. F.; Williams, R. C.; Mueller, H. A.; Ruffin, R. S.; Berry, E. R.; Guerry III, D. (Medical Coll. of Virginia, Richmond). Health Phys., 13: 681-700(July 1967).

The eyes of 120 rabbits, 8 to 12 weeks of age, were submitted to radiation exposures of 0, 200, 600, and 1000 R from a 1 MeV x-ray machine. The exposure was either to the whole eye (16 mm diam. beam) or to a portion of the eye (3 mm diam. beam). All animals received a biomicroscopic examination before irradiation and at 6 monthly intervals thereafter until death or sacrifice intervened. The colony of 120 rabbits was divided into six groups according to a balanced imcomplete block arrangement designed statistically for maximum information. Animals were sacrificed, four at a time, at 6 monthly intervals until each of the six groups was depleted. The relationship between ionizing radiation exposure and aging is assessed in terms of physical data involving the mass, density, hardness and light transmission of the rabbit lens, and in terms of clinical observations. These data indicate that changes in the physical properties of the lens are more affected by aging than by radiation, whereas the reverse is true for clinical changes as observed biomicroscopically. In general, the data lend support to the hypothesis that there may be a relationship between radiation damage and aging in the rabbit lens. (UK) (auth)

32779 FLASHBLINDNESS: THE EFFECTS OF PREFLASH ADAPTION AND PUPIL SIZE. Chisum, Gloria T.; Hill, J. H. (Naval Air Development Center, Warminster, Pa.). Aerospace Med., 38: 395-9(Apr. 1967).

A question of considerable operational importance is the extent to which the blinding effect of a flash from a nuclear weapon will vary with the ambient light level. Under conditions of darkness, the size of the pupil and the sensitivity of the eye are maximized. With an increase in the ambient light level both the sensitivity of the eye and the pupil size decrease. Data are presented on the independent effects of pupil size and receptor adaptation level on the production of flashblindness by high intensity, short-duration flashes. (auth)

32780 SYNTHETIC INHIBITORS AND NATURAL ANTIOXIDANTS. III. ANTI-OXIDATIVE ACTIVITY OF MOUSE LIVER LIPIDS IN TRANSPLANTED LEUKEMIA AND THE EFFECT OF INHIBITORS OF FREE RADICAL REACTIONS. Burlakova, E. B.; Pal'mina, N. P. (Inst. of Chemical Physics, Moscow). Biophysics, 11: 291-5(1966).

Translated from Biofizika, 11: 258-62(1966).

Changes in the anti-oxidative activity (AOA) of the liver lipids of leukemic mice in relation to the time elapsing after inoculation of leukemia cells were investigated. The development of the leukemia process occurred against a background of a raised level of AOA. When the leukemic mice were treated with daily injections of 4-hydroxy-3,5-di-tert-butyl-α-methylbenzylamine, the AOA was reduced; the AOA of control animals fell 1.5 times. Mice were irradiated with 200 to 500 R of x radiation at a dose rate of 40 to 50 R/min; irradiation produced a decrease in the AOA and the development of leukemia by injection of leukemia cells was retarded. The greatest inhibition of onset of leukemia was obtained with a radiation dose of 400 R; the mean life span of irradiated mice was 1.5 to 2 days longer than control leukemic mice. It was concluded that the ATO of liver lipids was an important factor in the development of inoculated leukemia. (B.H.S.)

32781 INHIBITION OF THE ANTIBODY FORMATION BY IONIZING WHOLE-BODY IRRADIATION. Buerki, K.; Cottier, H. (Univ., Bern). Radiol. Clin. Biol., 35: 345-52(1966). (In German).

The inhibiting effect of ionizing whole-body irradiation on antibody formation in mammals is described in a brief review. The extent of the so-called radiogenic immunosuppression depends strongly on the irradiation conditions, the species, and the type of the antigens used. Particular antigens, which remain longer in the organism than some soluble antigens, can cause an immunobiological response to stimulus in the recovery phase after irradiation. For testing of the suppressing effect of whole-body irradiation on the antibody producing cell system, liquid antigens, whose pertinent specific antibody can be determined by highly sensitive methods, are suitable. Tetanus toxoid is an example. Within a given dose range, the inhibiting effect is dependent on the radiation dose. With the same radiation dose, the suppression of the antibody formation depends on the time interval between irradiation and subsequent antigen stimulation. In an immunological response to stimulation in junction with an antigen injection, elements being differentiated from lymphoid cells to plasma cell recursors gain a radioresistance increasing with time. The susceptibility of whole-body irradiated animals to extracellular exciters as pneumococci or parasites (Trichinella spiralis) depends principally on the leukocyte count in the peripheral blood or in the tissue. Whole-body irradiated mice, in spite of persistant leucopenia, keep their natural and active immunity against influenza virus. The possible significance of these data is discussed. (tr-auth)

32782 THE GROSS RESPONSE OF AN EXPERIMENTAL TUMOUR TO SINGLE DOSES OF X-RAYS. Thomlinson, R. H.; Craddock, Elizabeth A. (Hammersmith Hospital, London). Brit. J. Cancer, 21: 108-23(Mar. 1967).

The gross response of benzopyrene-induced fibro-sarcoma in

rats appears to be made up of the compound effect of x radiation in killing clonogenic cells of the tumors, in altering the growth rate of survivors, and in causing damage to the vascular stroma. The response to changes in concentration of respired oxygen suggest that the effect on cell killing dominates the picture. This is perhaps to be expected in this tumor which is anaplastic, and which is so rapidly enlarging as to indicate that most of its cells are proliferating. However, even the oxygen enhancement ratio for the gross response of the tumor appears to be considerably greater than that of its clonogenic cells tested in vitro. The difference may be due to the effects on the capillaries. Caution is therefore necessary in deducing the effects of x radiation in killing cells from the gross response of tumors or in inducing hypotheses about the effects of radiation on whole tumors from cell survival observations alone. (auth)

32783 FATTY ACID CHANGES IN PIGEONS AFTER LETHAL-BODY RADIATION AND BONE MARROW AND THYMUS ADMINISTRATION. Chung, R. A.; Shaw, D. H.; So, E. S. (Tuskegee Inst., Ala.). Ind. Med. Surg., 36: 202-4(Mar. 1967).

Pigeons were γ-irradiated at 2900 rads, followed by injection of saline, heterologous bone marrow or thymus transplants, or a combination of bone marrow and thymus cell transplants. No pigeon with delayed hetertransplants showed prolonged survival time. Heart, liver, and breast tissues were analyzed for fatty acid composition by gas-liquid chromatography. A table summarizes the major fatty acid changes. These results confirmed earlier reports of a decrease in palmitic and oleic acid and in several polyunsaturated fatty acids. (C.O.)

32784 LONG-TERM EFFECTS OF SINGLE DOSES OF X RAY ON THE MANDIBULAR INCISOR OF RATS. Hwang, Wen-shui Shih; Cronkite, Eugene P. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res., 31: 1-7(May 1967).

The long-term effects on rat incisors after 150, 300, 600, or 1200 R of x irradiation during an observation period of 61 weeks are described. The eruption rates of animals receiving 150, 300, or 600 R were similar to those of the controls throughout the experiment. In the 1200 R irradiated animals the downward trend of decreasing eruption rate continued gradually, but an upward turn was noticed after the fourteenth week. The lowered eruption rate remained below that of controls at the termination of the experiment. The depressed zones in the enamel of the incisors were noted in animals receiving 150, 300, or 600 R in the sixth week and in those receiving 1200 R in the eighth to eleventh week post-irradiation. The severity and duration of the lesions were found to be dose-dependent. The depressed zones of the 150-R and 300-R irradiated animals had normal texture and pigmentation. Abnormal enamel was persistently observed in the regenerated incisors of the 1200-R irradiated animals. The significance of the observations is discussed. (auth)

32785 ACUTE GAMMA IRRADIATION EXPERIMENTS WITH THE LIZARD UTA STANSBURIANA. Turner, Frederick B.; Lannom, Joseph R.; Kania, Henry J.; Kowalewsky, Bruce W. (Univ.of California, Los Angeles). Contract AT(04-1)-GEN-12. Radiat. Res., 31: 27-35(May 1967). (UCLA-12-586).

Five experiments with young and adult Uta stansburiana indicate that, when this species is exposed to acute ^{60}Co radiations, the $LD_{50(30)}$ ranges from about 1700 to 2200 R (with standard deviations of the order of 300 to 400 R). Adult males were shown to be more radiosensitive than adult females, but no sex differences were observed in an experiment with animals 3 to 4 months of age. Doses were administered at 100 R/min and 200 R/min; the latter dose rate resulted in shorter survival times and (among adult males) a lower $LD_{50(30)}$. (auth)

32786 STUDIES ON THE RADIATION-INDUCED BREAKDOWN OF DEOXYRIBONUCLEIC ACID IN ESCHERICHIA COLI 15 T^-L^-. Achey, Phillip M.; Pollard, Ernest C. (Pennsylvania State Univ., University Park). Radiat. Res., 31: 47-62(May 1967).

The breakdown of E. coli DNA following γ irradiation was studied. The initial rate of degradation increases as the postirradiation incubation temperature is increased from 25°C to 41°C. Suspension of cells in 0.2 M ammonium acetate after irradiation inhibits degradation, but degradation is initiated when the cells are returned to growth medium. Bubbling with nitrogen after irradiation enhances the degradation. Cells growing in medium with succinate as the carbon source instead of glucose are more sensitive to the degradation process. The degradation process is not initiated by suspending the cells in irradiated medium. Autoradiography indicates that degradation occurs to nearly the same extent from cell to cell. A thin-layer chromatography study of the label lost by the cells into the medium indicates that it is thymine. It is found that there are two aspects of DNA degradation: the initiation of degradation, requiring radiation action within the cell; the expression of degradation following the irradiation, dependent on postirradiation environmental conditions. (auth)

32787 THE EFFECT OF X RAYS ON THE OVARIES OF THE PROGENY OF IRRADIATED MICE, WITH SPECIAL REFERENCE TO SMALL OOCYTES. Kochar, Nirmal K.; Batra, B. K. (Indian Cancer Research Center, Bombay). Radiat. Res., 31: 79-90(May 1967).

The present investigation is on the effects of x irradiation on the ovaries of mice derived from exposed oocytes. The ovaries were studied at different postconception ages to maturity. As the embryos developed from day 13 postcoitum to maturity, the ova underwent significant reduction. The degenerative processes which take place during early meiosis contribute to this reduction. It is concluded that irradiation of oocytes results in discernible alterations in the ova of the F_1 young. (auth)

32788 THE GEMINI-3 S-4 SPACEFLIGHT-RADIATION INTERACTION EXPERIMENT. Bender, M. A.; Gooch, P. C.; Kondo, S. (Oak Ridge National Lab., Tenn.). Radiat. Res., 31: 91-111(May 1967).

To test the suggestion that unusual radiobiological effects are associated with spaceflight, the S-4 experiment was carried out during the Gemini-3 manned spaceflight. The experiment consisted in the irradiation of duplicate series of whole-human-blood samples simultaneously on the ground and aboard the spacecraft during the orbital phase of the flight. After the mission a cytogenetic analysis was made to determine the frequencies of chromosome aberrations. Comparison of the ground and flight results showed that, although there was no significant difference between the yields of multiple-break aberrations, the yield of single-break aberrations was significantly higher in the flight samples. Several lines of evidence rule out the possibility that this difference was caused by any of the factors already known to influence chromosome aberration production. Preflight and postflight blood samples from the flight crew show that the spaceflight itself did not induce aberrations. A synergism thus appears to exist between radiation and some spaceflight parameter, at least for production of human chromosome aberrations. (auth)

32789 EVIDENCE FOR DARK-REACTIVATION OF ULTRAVIOLET LIGHT DAMAGE IN MOUSE L CELLS. Rauth, A. M. (Univ. of Toronto). Radiat. Res., 31: 121-38(May 1967).

The survival of colony-forming ability of mouse L cells after ultraviolet light (UVL) irradiation can be changed drastically by immediately incubating the cells in growth medium to which caffeine has been added. The nature of this effect is similar to previous results obtained by other workers for UVL-irradiated bacteria containing a dark-reactivation system. The nature of these similarities is as follows: The effect of caffeine on L cells is concentration-dependent in the range of 0.3 to 5mM, and it is purely a postirradiation phenomenon, being dependent on the time after irradiation that caffeine is added to the cells. Cells incubated for one generation time in the absence of caffeine show no decreased colony-forming ability when incubated in its presence. The caffeine effect is not seen if the cells are exposed to ionizing radiation instead of UVL irradiation. Substitution of some of the thymine moieties of L cell DNA with BUdR sensitizes the cell to UVL, but when such cells are plated in the presence of caffeine no further decrease in colony-forming ability is seen. These results can be interpreted in terms of L cells containing a dark-reactivation system capable of acting on UVL damage. (auth)

32790 THE DIRECT EFFECTS OF X IRRADIATION ON THE BIOSYNTHESIS OF ANDROGENS BY RAT TESTICULAR TISSUE IN VITRO. Simpson, C.Gordon; Ellis, LeGrande C. (Utah State Univ., Logan). Radiat. Res., 31: 139-48(May 1967). (TID-23697).

Male rats (Sprague-Dawley) were sacrificed when 12 weeks of age. Aliquots (0.4 gm) of a testicular mince from these animals were incubated and irradiated simultaneously for 15 minutes at 37.5°C in 10 ml of phosphate buffer, pH 7.4, containing 2.275 mμmoles of pregnenolone-7α-^3H and progesterone-4-^{14}C. One group of samples was exposed to 858 R of X-rays, while a second group was exposed to 4050 R during the 15-minute incubation period. Sham-irradiated control samples were irradiated and incubated with boiled testicular mince to ascertain if irradiation per se would decompose the radioactive steroid substrates. Irradiation of testicular mince with 858 R resulted in an increased androgen production. This increased androgen production was accompanied by a decreased 17α-hydroxylation and a decreased synthesis of compounds with a polarity greater than testosterone. At the higher dose, androgen synthesis and 17α-hydroxylation were diminished. No significant change in the total steroid biotransformations was noted with either dose of radiation. There was no significant difference in the recovery of the radioactively labeled steroids from the incubation mixtures, nor was there any appreciable decomposition of the steroid precursors when they were irradiated with as much as 6256 R in the presence of boiled testicular mince. (auth)

32791 OTDALENNYE REZUL'TATY VOZDEISTVIYA LUCHEI RENTGENA NA VYSSHUYU NERVNUYU DEYATEL'NOST' SOBAK. (Effects of X Irradiation on the Higher Nervous Systems in Dogs). Voevodina, O. N. Leningrad, Izdatel'stvo Meditsina, 1967. 147p.

This book deals with changes affecting complex conditioned motor activity in dogs both immediately after exposure to different doses of x irradiation and in animals born of irradiated females. Throughout their lives these animals showed functional weakness of higher nervous activity under the effect of various physiological and pharmacological factors. The book should appeal to radiobiologists, neuroradiobiologists, physiologists and clinicians. (auth)

32792 RADIOBIOLOGICKE METODY. (Radiobiological Methods). Hercik, Ferdinand (ed.). Prague, Academia Nakladatelstvi Ceskoslovenske Akademie Ved, 1966. 295p.

This well-documented book (approximately 850 references) contains chapters on basic definitions of pertinent physical terms, descriptions of radiation sources (machine, reactor, and radioisotope for alpha, beta, gamma, x, neutron, etc.); methods of determining radiation dose; effects of irradiation on viruses, microorganisms, cells, and tissues in vivo and in vitro, various insects, vertebrate and invertebrate animals, and plants; statistical methods of handling data; and health-physics regulations for ensuring safety in using radiation. (TTT)

32793 PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON THE CELL NUCLEUS: METABOLISM AND RADIOSENSITIVITY, 9–12 MAY 1966, RIJSWIJK (Z.H.), THE NETHERLANDS. London, Taylor and Francis Ltd., 1966. 358p. $12,85 cloth bound hard back; $10,70 stiff paper covers. (CONF-660560).

Knowledge concerning mitosis, regulation and differentiation, chromosomal organization and function, nuclear cytoplasmic relationships and metabolic capacities of cell nuclei, that is, DNA, RNA, protein synthesis and energy yielding reactions are discussed. The discussions on the various aspects of research on cell nuclei were presented in order that a more solid biochemical basis would be available for the elucidation of radiation effects at the cellular level. A brief review of the early biochemical changes that have been observed to occur in lymphatic cells such as thymocytes after exposure to x radiation and that can most plausibly be directly correlated with the observed morphological changes of nuclear homogenization and pyknosis is given. The breakdown of nuclear deoxyribonucleoprotein into polymerized DNA and histone and the various metabolic inhibitors on this process was with morphological changes. An aerobic metabolic process was required for these changes; the changes were greatly accelerated by inorganic phosphate in the suspension medium of the cells. (B.H.S.)

32794 RECOGNITION OF RADIATION-INDUCED LATE BONE MARROW CHANGES. Finch, Stuart C. (Yale Univ., New Haven). 14p. (CONF-660422-5). DTIE. Gmelin, AED-CONF-66-178-6.

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York.

Problems inherent in the recognition of radioinduced late changes in the bone marrow that developed from exposure to chronic low radiation doses and not from exposure to acute radiation doses are discussed. Included in the discussion are descriptions of the postirradiation changes that occurred in the blood cells of persons who were exposed to acute or chronic radiation doses. The hematologic effects of the chronic low radiation dose received after administration of thorium dioxide are also discussed. (B.H.S.)

Radiation Effects on Plants

Refer also to abstracts 32620, 32728, 32729, and 32792.

32795 (NYO-3597-3) AN EXPERIMENTAL STUDY OF LEAF DEVELOPMENT IN CERTAIN OF THE VASCULAR PLANTS. Period Covered: September 1, 1966–August 31, 1967. Kuehnert, Charles Carroll (Syracuse Univ., N. Y.). May 1967. Contract AT(30-1)-3597. 24p. Dep. CFSTI.

Morphogenetic studies of leaf development in sterile culture were continued with emphasis directed toward elucidating biochemical and physical factors that influence establishment of the leaf pattern of development in the undetermined primordium and perpetuation of this pattern in the developing organ. Major consideration is to be given to: further demonstration, and possible characterization, of a leaf-ness morphogen in determined primordia that will influence undetermined primordia to develop as leaves rather than shoots; studies concerned with cytohistological changes associated with expression of leaf-ness or shoot-ness in undetermined primordia; a study to determine whether a correlation between x radiation and DNA level can be made relative to induction of shoot-ness in undetermined primordia; study of the influence of gibberellic acid (GA_3) and kinetin on the leaf/shoot expression of undetermined primordia. Results to date indicate: undetermined primordia (P_3's) grown in physiological contact with determined primordia (P_{10}'s or P_{12}'s) exhibit a greater than two-fold increase in leaf-ness over undetermined primordia grown singly or as paired units; a similar expression occurred when determined primordia were separated from undetermined primordia by a porous membrane; undetermined primordia grown on homogenate of determined primordia also expressed the leaf-ness characteristic at the same level; light mediated photomorphogenic control appeared to exist for undetermined primordia grown under high energy blue light influenced undetermined primordia to develop as leaves, and this response was mimicked by high-energy far-red light; GA_3 at 2.3×10^{-5} M depresses shoot-ness in undetermined primordia; and conversely, kinetin at 4.6×10^{-6} M enhances shoot-ness in undetermined primordia. (auth)

32796 (TID-23842) RADIATION-INDUCED AFTER EFFECT AND LONG-LIVED FREE RADICALS. Final Scientific Report, June 5, 1959–December 1964. Conger, Alan D. (Florida Univ., Gainesville. Brookhaven National Lab., Upton, N. Y. Temple Univ., Philadelphia, Pa. School of Medicine). May 1967. Contract AT(40-1)-2579. 11p. Dep. CFSTI.

Research is reported on: factors modifying the relation of yield, decay, and type of radioinduced free radicals to amount of biological damage in seeds; the effects of H_2S on biological damage and free radicals in irradiated seeds; the relation between seedling height and chromosome aberrations in plants from irradiated seed; cytological analysis and model for anaphase bridges in Tradescantia in relation to dose; and the influence of high magnetic fields on radiation damage in dry seeds. (H.G.D.)

32797 INVESTIGATION OF THE FIRST POSTRADIATIONAL MITOSIS IN SPROUTS OF DIPLOID AND AUTOTETRAPLOID RYE. Demchenko, V. E.; Safin, M. K. Dopov. Akad. Nauk Ukr. RSR, Ser. B, No. 2, 174-7(Feb. 1967). (In Ukrainian).

Sprouts of diploid and autotetraploid rye of the Vyatka variety were irradiated on a gamma-ray device. As a result of a cytogenetic analysis of the first post-radiational mitosis (diffused effect of radiation) it was found that the susceptibility of tetraploid rye, estimated by the percentage of injured cells at the anaphase stage, is higher than that of the diploid. The differences between the closes with respect to maximum frequency of anomalous mitoses were negligible. The quantity of aberrations in the cells of both forms of rye were close, i.e., did not depend on the number of chromosomes. (auth)

32798 PRELIMINARY DATA ON RADIATION-INDUCED GAMETE STERILITY IN M_1 PLANTS OF NICOTIANA TABACUM. Monti, L. M. (CNEN, Casaccia, Italy). Radiat. Bot., 7: 177-82 (June 1967).

In a study of the sterility of male and female gametes of M_1 plants arising from mutagenic treatments, 7 M_1 plants of Nicotiana tabacum "purpurea" originating from irradiated zygotes (4 kR of γ-rays) were paired with 7 control plants. In each of the 7 pairs, self-pollinations of the control and M_1 plants and both reciprocal crosses were performed 5 times. Data were obtained on pollen fertility (by a staining test), seed set, seed germination and number of seedlings per fruit. The female and the male gametes of the M_1 plant were both found to produce sterility when crossed to a control plant. Comparison between the two reciprocal crosses showed that the average contribution of M_1 egg cells to the total amount of sterility of the 7 M_1 plants was no larger than that due to the corresponding pollen grains. The fact that the M_1 pollen grains, despite their numerical superiority, determine a sterility effect no lower than that induced by the M_1 egg cells, is explained by a greater ability of the female gametes to tolerate the genetic damage induced from the mutagenic treatment. (UK) (auth)

32799 EFFECT OF X-IRRADIATION AND POST IRRADIATION STORAGE OF PEANUT SEED ON NUCLEIC ACID METABOLISM IN COTYLEDONS. van Huystee, R.; Cherry, J. H. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1313. Radiat. Bot., 7: 217-23(June 1967). (COO-1313-17).

Exposure of peanut seeds to 250 and 500 kR of X-rays reduced germination by 30 and 50 percent, respectively. The same X-ray dosages inhibited seedling growth by as much as 60 percent. Radiation levels of 750 kR and higher completely inhibited seed germination. Nucleic acid synthesis of cotyledons was stimulated by X-irradiation if the seeds were germinated and analyzed immediately after irradiation exposures of 250 and 500 kR. Storage of the seeds for 2 and 4 weeks after irradiation reduced the X-ray enhanced nucleic acid synthesis. After 4 weeks of storage all irradiation exposures inhibited nucleic acid synthesis. Fractionation of nucleic acids on methylated albumin columns revealed that all RNA fractions were affected the same way for each irradiation exposure and for different times of storage. (auth) (UK)

32800 MODIFICATION OF X-RAY SENSITIVITY BY METAL IONS IN CROTALARIA INTERMEDIA SEEDS. Bhatia, C. R. (Univ. of Agriculture, Wageningen, Netherlands. Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Radiat. Bot., 7: 161-5(June 1967). (BNL-10317).

The effect of metal ions, present during irradiation, on sensitivity to X-irradiation of dry Crotalaria intermedia seeds was investigated. Seeds soaked for 10 hr in 0.01M $ZnSO_4$, $CuSO_4$, $MnSO_4$ and $MgSO_4$ were dried and equilibrated for moisture content at relative humidities of 5 and 32 per cent, in air or in nitrogen, prior to X-irradiation in the same atmosphere. The number of mutated sectors appearing on the first leaf was used as a measure of radiation effect. The results indicated that the presence of cupric ions during X-irradiation enhanced the effect. Other metal ions did not show any significant modification of radiation effect. It is suggested that the observed sensitization by cupric ions may be due to binding of the metal ions with DNA and other macromolecules, thus causing increased vulnerability to damage by radicals produced. (auth) (UK)

32801 THE RATE OF CELL DIVISION ACCORDING TO THE RIPENESS OF VARIOUS TYPE OF COTTON AND UNDER THE EFFECTS OF ^{60}Co γ IRRADIATION. Nazirov, N. N.; Zapruder, E. G. (Inst. of Genetics and Physiology of Plants, Tashkent). Dokl. Akad. Nauk Uz. SSR, No. 2, 48-51(1967). (In Russian).

The rate of cell division under normal conditions and after ^{60}Co γ irradiation was studied using early-ripening 1306-DV and late-ripening C-1622 types of Gg. hirsutum. Irradiation of germinating seeds of C-1622 with 1 Ci dose and 1306-DV with 2 Ci delayed the cell division; irradiation of C-1622 with 10 Ci inhibited the mitotic development of rootlets within 3 hr following the exposure and completely stopped development after 24 hr. However, in contrast to the C-1622, the 1306-DV cotton seeds continued their mitotic development at sufficiently high levels even after 2 days and only on the third day was development arrested. Irradiation of air-dried seeds with a double dose (20 Ci) induced only partial inhibition of mitotic development of rootlets. Thus, it was found that radiosensitivity of sprouting cotton seeds is 10 to 20 times higher than that of air-dried seeds and that the late-ripening types are 2 to 4 times more sensitive to radiation than the early ripening ones. (R.V.J.)

32802 ACTION OF X RAYS ON THE FORMATION OF GENTISIC ACID IN THE TUBER TISSUES OF JERUSALEM ARTICHOKE (HELIANTHUS TUBEROSUS L., var. VIOLET DE RENNES) CULTIVATED IN VITRO. Jonard, Robert; Paupardin, Colette (CPEM, Paris). Compt. Rend., Ser. D, 264: 2234-5 (May 3, 1967). (In French).

The formation of gentisic acid in the tubers of x-irradiated artichokes exposed to doses of 1000, 2000, and 3000 rad was investigated. At these doses, inhibition of the tuber growth was 39, 50, and 61%, respectively. The determination of gentisic acid after 40 days showed that a dose of 1000 rad sharply stimulated the formation of the acid; higher doses inhibited the formation. (J.S.R.)

Radiation Effects on Microorganisms

Refer also to abstracts 32578, 32728, 32729, and 32792.

32803 (NYO-3319-15) RADIORESISTANCE OF MICROCOCCUS RADIODURANS DURING THE GROWTH CYCLE. Serianni, R. W.; Bruce, A. K. (State Univ. of New York, Buffalo. Dept. of Biology). [nd]. Contract AT(30-1)-3319. 8p. (CONF-670526-1). Dep. CFSTI.

From 15th Annual Meeting of the Radiation Research Society, San Juan, Puerto Rico.

The radiosensitivity of Micrococcus radiodurans during the growth cycle was studied in relation to culture media. Investigations conducted on cells cultured in a chemically defined synthetic medium showed a significant dose-response effect of x irradiation in respect to physiological age. The exponential phase of growth was the most radiosensitive phase in cells grown on complete media, with maximum resistance occurring upon passage of the culture into stationary phase. Parallel studies were made on the cells' response to uv vs their physiological age. A direct relation between x irradiation and uv radiation with respect to physiological age was not evident. It is concluded that the dose-response relationships are a function of a biphasic system that alters both the slope and the shoulder of the survival curve independently. (H.G.D.)

32804 (USNRDL-TR-67-58) EFFECTS OF ULTRAVIOLET LIGHT IRRADIATION AND HEAT SHOCKS ON CELL DIVISION IN SYNCHRONIZED TETRAHYMENA. Nachtwey, D. Stuart; Fiese, A. C. (Naval Radiological Defense Lab., San Francisco, Calif.). May 24, 1967. 28p. CFSTI.

The division of synchronized Tetrahymena pyriformis (strain W) irradiated with low doses of ultraviolet light was delayed if the irradiation was administered during the first 30 minutes after the end of the synchronizing treatment. After a short period of transition, division in most cells was not delayed even by relatively high doses. The delay induced by a particular low dose administered at any time up to the transition to insensitivity was essentially constant. The division of synchronized cells was delayed by heat shocks (34° ± 0.1°C, for 20 minutes) applied at any time up to approximately 60 minutes after the end of the synchronizing treatment. After this time, for any single cell in a sample, there was an instantaneous transition to heat-shock insensitivity. The delays in cell division induced by heat shocks increased with time from the end of the synchronizing treatment, attaining a maximum just before the transition to insensitivity. The two different transition times in the responses of synchronized cells to uv and to heat shock were interpreted as representing the completion of two different processes in the final preparation of the cells for division. The qualitative and quantitative differences between the responses to uv and to heat shock suggested that two different substances were involved, one sensitive to uv and one to heat. Some evidence is presented that suggested that the completion of the heat-sensitive process depended upon the uv-sensitive process. (auth)

32805 STUDIES ON RADIOSENSITIVITY DURING THE CELL CYCLE IN OEDOGONIUM CARDIACUM. Horsley, R. J.; Fucikovsky, L. A.; Banerjee, S. N. (Ontario Cancer Treatment and Research Foundation, Hamilton). Radiat. Bot., 7: 241-6(June 1967).

Dose response curves were measured at different times during the cell cycle of synchronously growing Oedogonium cardiacum zoospores. During the G_1 period there was a marked increase in γ radiosensitivity, as measured by loss of cell reproductive integrity, yielding a multi-component dose response curve with at least two distinct D_0 values. During the cell cycle the D_0 values changed by a factor of 7 from about 950 rad at the end of G_1 and beginning of S to 140 rad in G_2. As D_0 decreased the value of the extrapolation number and the shoulder width also decreased. (auth) (UK)

32806 MULTIPLICITY REACTIVATION IN GAMMA IRRADIATED INFLUENZA VIRUSES. Gilker, J. C.; Pavilanis, V.; Ghys, R. (Univ. of Montreal). Nature (London), 214: 1235-7 (June 17, 1967).

Multiplicity reactivation was first demonstrated in bacteriophages irradiated with uv light. Later the same effect was shown in influenza viruses, uv irradiated and grown in chick embryos. The studies described concern the influence of various physical factors on the inactivation of influenza viruses by gamma irradiation. Irradiation was at 4×10^5 R/hr, at 20°C and −78.5°C. The viruses studied were A1/AA/1/52, A2/Australia/57, B/GL/1739/54, and B/Taiwan/63. By exposing the viruses to 4×10^5R complete loss of infectivity was obtained, while hemagglutinin properties were unchanged. The experimental technique is described in detail. A graph is given showing the first order dose response curve of the residual virus (A2/Australia/57) infectivity after gamma irradiation. It was found that the magnitude of response was temperature dependent, the lower temperature causing a radioprotective effect on the virus. A graph is also given showing multiplication of A2/Australia/57 virus, as expressed by its hemagglutinin power, as a function of time after inoculation to chick embryos — also a graph showing the multiplication of the virus as expressed by its infectivity as a function of time of incubation. The results indicate that multiplicity reactivation can occur in influenza viruses exposed to high energy ionizing radiation. (UK)

32807 STOMATOGENESIS AND CELL DIVISION IN EUPLOTES INHIBITED BY ULTRAVIOLET MICROBEAM IRRADIATION. Shimomura, T.; Naruse, S.; Takeda, S. (Mie Prefectural Univ., Tsu, Japan). Nature (London), 215: 91-2(July 1, 1967).

Selective irradiation of a small part of a living cell with an uv microbeam has been used to investigate functions of cellular organelles. Functions of the kinetochore, centriole and spindle fibre have been investigated in grasshopper and newt cells in culture, as well as functions of the nucleolus in He La cells in culture. Radiation damage and recovery in a living cell have also been examined by this technique. The studies involved selective blocking of stomatogenesis and were intended to show the close relationship between stomatogenesis and cell division. In the studies described the cell material used was Euplotes eurystomus Stock III, and the cells were cultivated in wheat extract at 22°C, with Chilomonas paramecium as bait. Exposure time was 2 to 3 min. Experimental details are described. From morphological findings of the stomatogenesis on the cell surface and the reorganization bands of the macro-nucleus it was found that the mitotic cycle of the Euplotes

cells could be divided into three stages (1) a period showing no stomatogenesis and no DNA synthesis, (2) a period involving both processes, (3) a period of cytokinesis. Part-cell irradiations during these stages are described. The results strongly suggest that stomatogenesis is a trigger mechanism in the onset of division in Euplotes, and that, when oral formation has commenced, the process becomes relatively resistant to uv irradiation. The resistance of the stomatogenic region in the rapidly growing cells may be associated with the radiation damage recovery processes. Some results with Tetrahymena are also mentioned. (UK)

32808 RADIOSENSITIVITY IN RELATION TO THE CELL CYCLE AND RECOVERY FROM X-RAY SUBLETHAL DAMAGE IN DIPLOID YEAST. Bacchetti, Silvia; Cassandro, M.; Mauro, F. (Univ., Rome). Exp. Cell Res., 46: 292-300(May 1967).

Experiments on recovery of diploid yeast from sublethal x radiation damage, the effects of dose fractionation, and on variation of radiosensitivity within a single division cycle are reported. The radiosensitivity was tested on a synchronized population; for the recovery experiments, both synchronized and asynchronous populations were used. The changes in sensitivity can be observed also in the kinetics of the recovery process which has been interpreted according to the recovery + progression model. The results point out that the radiation response of yeast cells is remarkably similar to that of mammalian cells cultured in vitro. Inferences on the relationship between budding and radioresistance and on the identification of the phase of the mitotic cycle responsible for the different sensitivities are presented. (auth)

32809 THE SIGNIFICANCE OF THE AFTER TREATMENT FOR THE FIXATION OF RADIATION DAMAGE (EXPERIMENTS IN SCHIZOSACCHAROMYCES POMBE WITH FAST NEUTRONS AND SOFT X RAYS). Blattmann, H. (Univ., Zurich). Radiol. Clin. Biol., 35: 353-7(1966). (In German).

Cells of the yeast Schizosaccharomyces pombe were irradiated with fast neutrons and 100 keV x rays. The effect of mitotic rest after irradiation was investigated. It is noticeable only after x radiation. The oxygen effect was compared for the various types of radiation. No difference was found between x radiation and neutrons. The RBE factor for the reactor neutrons was dependent on the after-treatment. (tr-auth)

32810 ULTRAVIOLET SENSITIVITY OF THE BIOLOGICAL ACTIVITY OF ϕX 174 VIRUS, SINGLE-STRANDED DNA, AND RF DNA. Yarus, Michael; Sinsheimer, Robert L. (California Inst. of Tech., Pasadena). Biophys. J., 7: 267-78(May 1967).

Action spectra for inactivation of ϕX virus, free ϕX single-stranded DNA, and double-stranded ϕX DNA (RF) have been measured using light of wavelength 225–302 mμ. The sensitivity of RF has been determined using bacterial hosts both capable and incapable of reactivation of UV damage. The inactivation of ϕX virus is due, at all wavelengths, to damage to its DNA; it appears that, below 240 mμ, energy adsorbed by viral structural protein may inactivate the viral DNA. The variation of the probability of inactivation by an absorbed quantum (quantum yield) with wavelength, in the case of free-single-stranded ϕX DNA, suggests that energy absorbed by pyrimidine residues is more likely to yield inactivation than absorption by purines. This implies that energy transfer is not so extensive as to make all absorbed energy available to pyrimidines. (auth)

32811 THYMINELESS DEATH IN ESCHERICHIA COLI: STRAIN SPECIFICITY. Cummings, Donald J.; Mondale, Lee (Univ. of Colorado, Denver). J. Bacteriol., 93: 1917-24(June 1967).

Thymineless death of various ultraviolet (uv) sensitive strains of Escherchia coli B and K-12 was investigated. It was found that E. coli B, B_{s-12}, K-12 rec-21, and possibly K-12 Lon, all sensitive to uv, were also sensitive to thymine starvation. However, other uv sensitive strains of E. coli were found to display the typical resistant-type kinetics of thymineless death. The correlation of these results with various other cellular processes suggested that the filament-forming ability of the bacteria might be involved in the mechanism of thymineless death. It was apparent from the results that capacity for host-cell reactivation, recombination ability, thymine dimer excision, and probably induction of a defective prophage had little to do with determining sensitivity to thymine deprivation. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 32329, 32755, and 32770.

32812 (SGAE-BL-19/1967) KONSERVIERUNG VON BROT MITTELS GAMMASTRAHLUNG. (Preservation of Bread by Gamma Irradiation). Stehlik, G.; Kaindl, K. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Biologie und Landwirtschaft). 1967. 27p. (In German). Dep.

The extension of the storage-life of slices of bread using γ irradiation alone and also combined with heat or chemical pretreatment was investigated. Results showed that by using combined methods to extend storage-life to 8 to 10 weeks it was possible to apply doses which are already authorized in the USA for wheat and wheaten flour. The organoleptic qualities of this bread were also investigated. No difference could be noted immediately after irradiation, even at a dose of 5×10^5 rad, in comparison with the non-irradiated control sample. After storing the irradiated sample for 2 months at room temperature there was naturally a deterioration in quality in comparison to fresh bread; this, however, was due to the long storage period and not to the irradiation itself. The quality of the irradiated bread, in comparison to the canned sample, was slightly better. (auth)

32813 IRRADIATED BLOOD MEAL AND BONEMEAL FOR RATS. Eggum, Bjoern O.; Swift, Robert L. (Landoekonomisk Forsogslaboratoriums, Copenhagen). Landokonom. Forsogslab. Arbog, (Copenhagen), 45-7(1965). (In Danish).

Heat-sterilized and radiosterilized blood and bone meal, used for fattening pigs, were comparatively tested for nutritive value in rats. The heat-treated materials were maintained at 125°C for 15 min and the radiation-treated material were sterilized with 500,000- to 2,000,000-rad doses of γ radiation. When tested as the only protein supplement of the diet or when combined with soybean meal, both irradiated blood meal and bone meal proved to be more efficient for growth in rats than the heat-treated counterparts. It was evident that the protein-anabolic efficiency of the irradiated products was higher than that of the heat-sterilized materials. This was confirmed by the higher contents of essential amino acids, especially lysine, in the radiosterilized feed. (BBB)

32814 PROGRESS OF FOOD IRRADIATION WORK AND PROGRAMMES IN O.E.C.D. MEMBER COUNTRIES. Food Irradiat., 7: No. 3, 2-40(Jan.–Mar. 1967).

The current status of research projects on food irradiation in O.E.C.D. member countries is described. Summaries of progress in basic research, industrial development, irradiation sources and facilities, legislation, publication, and wholesomeness testing are included. (B.H.S.)

32815 IRRADIATION OF POTATOES IN PAKISTAN. Farooqi, W. A.; Mohyuddin, M.; Hamid, M. A. (Atomic Energy Centre, Lahore). Food Irradiat., 7: No. 3, 41-4(Jan.–Mar. 1967).

Pototoes of the Ultimus Holland variety were γ-irradiated in bulk at 2 to 10 krad and then stored at 83°F and 69% relative humidity. Results on the effects of radiation on sprout length, incidence of storage rot, and weight loss due to storage and sprouting are presented in tabular form. It was concluded that with the increase of the radiation dose, loss of water content and the incidence of storage rot was greatly reduced. The radiation dose of 2 krad showed a stimulation effect on sprouting. (B.H.S.)

32816 THE TECHNICAL BASIS FOR LEGISLATION ON IRRADIATED FOOD. REPORT OF A JOINT FAO-IAEA-WHO EXPERT COMMITTEE: ROME, 21-28, APRIL 1964. World Health Organ., Tech. Rep. Ser., No. 316, 1-37(1966).

General principles governing the production and use of irradiated food are considered, along with recommendations for the establishment of legislation and control. Recommended technical procedures and tests required to permit an evaluation of the safety for consumption of irradiated food are outlined, including tests for microbiological safety. It is recommended that distribution of a specified irradiated food intended for general public consumption should be permitted only after acceptance by the appropriate government authority of evidence that the food is safe for human consumption. Legal control of irradiated food can be best accomplished by the use of a list of permitted foods irradiated under specific conditions. Irradiation of feed intended for consumption by animals should be subjected to control by procedures analogous to those used for the control of irradiated food for human consumption. An appendix is provided which furnishes information on the technology of the irradiation process, technical terms used in this report, type of information to be submitted in support of a request to irradiate a specific food intended for general distribution, detection of previous treatment by irradiation, and an example of protocols for animal feeding studies on irradiated food. (BBB)

32817 EFFECT OF GAMMA IRRADIATION ON MALTING BARLEY. Fujii, Toshikatsu; Lewis, Michaelis J. Rep. Res. Lab. Kirin Brewery Co., Ltd., No. 8, 59-66(Dec. 1965).

Results of the experiments reported confirm the dependence of the aleurone layer on stimulation by the embryo, prior to produc-

tion of amylase enzymes during germination of barley. The results show, in addition, that the hormone capable of stimulating the aleurone layer to synthesize enzymes appears in the embryo just prior to stimulation of the aleurone layer. Gamma irradiation of barley causes greater damage to the embryo than to the endosperm (aleurone layer) of the barleycorn, and it is primarily this inactivation of the embryo that causes decreased enzymatic content of malts made from irradiated barley. Irradiation significantly reduces rootlet growth as part of the overall reduction of the metabolic activity of the embryo. (NSA of Japan)

32818 STUDIES ON THE ERADICATION OF ANOPHELES PHAROENSIS BY THE STERILE-MALE TECHNIQUE USING ^{60}Co. III. DETERMINATION OF THE STERILE DOSE AND ITS BIOLOGICAL EFFECTS ON DIFFERENT CHARACTERS RELATED TO "FITNESS" COMPONENTS. Abdel-Malek, A. A.; Tantawy, A. O.; Wakid, A. M. (Middle Eastern Region Radioisotope Center for the Arab Countries, Cairo). J. Econ. Entomol., 60: 20-3 (Feb. 1967).

Mosquito pupae were subjected to various doses of γ rays from ^{60}Co, i.e., 10,000 to 13,000 R with 1000 R increments, to study their effects on lifetime egg production, egg hatchability, and longevity of adult mosquitoes and to find the exact dose of γ rays which may cause complete male sterility. The sterilizing dose (12,000 R) was used to investigate its adverse effects on pupae of different ages and the dose fractionation on the emerged adults. The results indicated the adverse effects of high doses of γ radiation on all characters studied except longevity of adult mosquitoes. A dose of 12,000 R caused complete sterility in both sexes. The results suggested that it was better to give the whole amount of the sterilization dose at once rather than in fractions when pupae aged 15 to 20 hr were used. When unirradiated females were mated with irradiated males, egg production did not change significantly, but only 10 larvae emerged from 15,204 eggs, giving a hatch of 0.065% as compared with 91.42% in the controls. Longevity of the F_1 offspring was not affected by different treatments given to the parental pupae. (BBB)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 33528.

32819 TRANSACTIONS VACUUM METALLURGY CONFERENCE, NEW YORK, JUNE 27, 28, AND 29, 1966. Orehoski, M. A.; Bunshah, R. F. (eds.). Boston, American Vacuum Society, 1967. 471p. (CONF-660630).

Technology concerning the use of vacuum techniques for manufacturing heat-resisting alloys and metals and steels is discussed. Included are discussions of new techniques for vacuum melting, refining, and purifying metals along with discussions of other new vacuum techniques. A total of twenty-three papers is presented. (J.R.D.)

32820 PLUTONIUM 1965. Proceedings of the Third International Conference on Plutonium, London, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967. 1125p. $45.00. (CONF-651102).

The conference papers are divided into 8 sections entitled: transformation studies, physical properties, alloy systems, mechanical properties, corrosion, studies on ceramic fuels, ceramic phase studies, and irradiation behavior. At least one discussion section, sometimes 2, are included in each general section. No abstracts were prepared for the discussions. 62 papers are included. Abstracts have been prepared for 4 very brief papers, and author abstracts are presented for 50 other papers. 8 papers have been previously abstracted. See NSA 19: 44689; 19: 44690; 19: 47880; 19: 46999; 20: 744; 20: 822; and 20: 7568. (B.L.M.)

For abstracts of individual papers see: 32826, 32827, 32869–32880, 32905–32919, 32937, 32938, 32948, 32949, 32956–32960, 32977–32980, 32994–32996, and 33008–33016.

Corrosion and Erosion

Refer also to abstracts 32876, 32883, 34096, and 34114.

32821 (AECL–2878) CHLORIDE STRESS CORROSION CRACKING IN THREADED 300 SERIES STAINLESS STEEL COMPONENTS. Gibson, S. P.; Evans, W.; Watson, R. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). May 1967. 16p. (CONF-670522–3). Dep. CFSTI. CAN $0.50.

From International Conference on World Review of Nuclear Reactors and Radioisotopes, Montreal, Canada.

Results of examination of type 316 stainless steel strainer plugs and of type 300 stainless steel valves which failed under operating conditions in the high temperature water systems at CRNL are reported. The failures resulted from stress corrosion cracking caused by use of chloro-fluoro organic compounds for thread lubrication. It is concluded that lubricants containing chloro or chloro-fluoro compounds should not be used as lubricants on 300 series stainless steels in high temperature water systems. (P.G.C.)

32822 (EUR–3476.f) TRAITEMENT DE SURFACE D'ALLIAGES DE ZIRCONIUM PAR LES SELS FONDUS OXYDANTS. (Surface Treatment of Zirconium Alloys by Oxidizing Fused Salts). Hardy-Grena, C.; Avogadro, A.; Wurm, J.-G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 1967. 30p. (In French). Dep.

An oxidation coating method of Zr alloys was improved: it consists of thermal treatment in a fused $NaNO_3$ bath. Specimens were tested for H_2 pick-up in H_2 atmosphere and pure terphenyl; they gave favorable results. Terphenyl containing 5 ppM Cl_2 attacked alloys severely, certainly by a Cl_2 catalytic action. (auth)

32823 (GEAP–5281) STAINLESS STEEL FAILURE INVESTIGATION PROGRAM. Quarterly Report No. 6, July 1–October 31, 1966. Duncan, R. N. (comp.) (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). Dec. 1966. Contract AT(04-3)-189. 58p. (EURAEC–1831). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Results of corrosion tests on high-purity stainless steels, with minor additions of impurities, conducted in solutions of HNO_3 + Cr^{+6}, and in $FeCl_2$ are reported. Specimens of types 348 and 304 stainless steel cladding were evaluated for susceptibility to intergranular attack before and after irradiation. Research on effects of applied stresses on fuel cladding as related to intergranular corrosion attack indicates that low-cycle fatigue is not a significant factor in intergranular failure mechanisms, that corrosion film material is not propagated into the cladding by cyclic flexing, but that surface strains of 0.006 in./in. can be related to formation or presence of intergranular attack in irradiated unsensitized type-304 stainless steel after operation in a BWR environment. (P.G.C.)

32824 (JAERI–1129) LIQUID SODIUM TECHNOLOGY DEVELOPMENT. I. TEST LOOPS, PURIFICATION METHODS, AND SUPPLEMENTARY TECHNIQUES. Furukawa, Kazuo; Yamamoto, Ken; Nihei, Isao; Iguchi, Yae (Japan Atomic Energy Research Inst., Tokyo). Nov. 1965. 32p. Dep.

The initial results of the development program of liquid Na loops and associated technology are reported for the period 1957 to 1965. Test loops such as corrosion test loop, purification test loop and mother and daughter test loop system, and their operating experiences are described. In mother and daughter test loop system, various tests are made with daughter test loops, using Na with given contents of impurities which are controlled in the mother loop. Then, the results of development and operating procedures are described for the purification system (cold trap, cold finger and hot trap). The first model of the cold trap has a Na-oxide removal-capacity of 1.3 kg/30 l. Improvements to this trap are proposed for increasing the capacity to three times the initial one by controlling internal temperature distribution. The results of corrosion and carburization tests are also shown. In the tests, emphasis was placed on austenitic stainless steels (304, 316, 347 S.S.), followed by Cr–Mo steels and refractory metals (Nb, Ta, Mo, Zr, and Ti). The analytical data and behaviors are also described for O, C, etc. in Na. The results of developments, and the precautions to be taken in operation are shown for various instruments (impurity-, level-, pressure- and flow-meters), preheating system, component recleaning method, and hazard protections (Na handling, protective clothes and fire extinguishing). (auth)

32825 (NASA-CR–72230) ADVANCED REFRACTORY ALLOY CORROSION LOOP PROGRAM. Quarterly Progress Report No. 7, October 15, 1966–January 15, 1967. Harrison, R. W. (ed.) (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section). Jan. 28, 1967. Contract NAS 3-6474. 58p.

Progress on testing and inspection of T-111 alloy tubing and other components for a K corrosion test loop is reported. Microstructure and microhardness measurements of Cb-132M and TZC alloys are shown as are results of physical tests. Photographs of a Li still, now installed in the system, are also shown. (P.G.C.)

32826 SOME OBSERVATIONS ON THE OXIDATION OF UNALLOYED AND δ-STABILIZED PLUTONIUM METAL. Raynor, J. B.; Sackman, J. F. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 575-91 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22-26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967. See CONF-651102.

Results for unalloyed Pu in air showed that disintegration of the metal and sharpness of breakaway of the oxidation curves are related to the purity of the metal, and that a wide variation in oxidation behavior only occurs under humid conditions. Under these conditions moisture and CO_2 are strongly combined with the products of oxidation. In moist Ar, both alloyed and unalloyed plutonium oxidizes faster than in moist air; at ~30°C and 95% relative humidity, the rates are faster by factors of 70 and 6 for the 1 at. % Ga alloy and unalloyed plutonium respectively, with the result that (under these conditions) alloyed plutonium oxidized faster in moist Ar, than unalloyed plutonium, whereas the reverse is the case in moist air, and in moist Ar at higher temperatures. (auth)

32827 OXIDATION MEASUREMENTS ON α PLUTONIUM IN VARIOUS GLOVE BOX ATMOSPHERES. Tanon, A.; Bordes-Pages, H. (CEA, Paris). pp 603-16 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22-26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Two series of experiments were carried out in order to compare the oxidation rates of Pu in atmospheres of air, N_2, purified Ar, O_2, and O_2–Ar mixtures near ambient temperature. The first shows clearly that dry air is the least oxidizing atmosphere, revealing the protective nature of oxide films formed in contact with air and with O_2. The second shows that the rate of oxidation increases when the O_2 content of the O_2/Ar mixture decreases,

indicating a corresponding decrease in the protective nature of the oxide. (auth)

32828 CORROSION RESISTANCE OF PLATINUM, COPPER, NICKEL, AND TANTALUM IN LIQUID OXYGEN DIFLUORIDE. Toy, S. M. (Douglas Aircraft Co., Inc., Newport Beach, Calif.). J. Electrochem. Soc., 114: 706-7(July 1967).

The corrosion resistances of Pt, Cu, Ni, and Ta in liquid OF_2 at cryogenic temperatures were estimated from changes in solution capacitance and conductance between two plates of these materials. Results were compared with those of the weight change method. (J.G.B.)

32829 OXIDATION OF β-ZIRCONIUM UNDER VERY LOW PRESSURE. SUPERFICIAL ASPECTS CAUSED BY THE ZIRCONIUM–OXYGEN MIXTURE. Renucci, L.; Langeron, J. P. (CNRS, Paris). J. Nucl. Mater., 23: 79-87(July 1967). (In French).

A study was made of the contamination, attributed to O_2, of Zr in the β phase. Van Arkel metal of high purity was used. For samples 0.5 mm thick, contamination amounted to 2.1 ppM/hr during anneals at a pressure of 1.5×10^{-7} torr, and 19 ppM/hr at a pressure of 2×10^{-6} torr. This oxidation appeared to follow linear kinetics, which implies oxidation without the formation of an oxide layer or α Zr. The O_2 concentration gradient between the surface and the interior always remained small, and at the surface the O_2 concentration was 430 ppM or less. On samples that contain about 400 ppM of O_2 or more, striations or facets appear at the surface of the β grains; this phenomenon is due to the presence of a chemisorbed O_2 layer. It is suggested that there is an equilibrium between dissolved O_2 and the density of the adsorbed layer. However, under the conditions of the experiments, no equilibrium can arise between gaseous O_2 and chemisorbed O_2. (auth)

32830 OXIDATION OF ZIRCONIUM BY CARBON MONOXIDE. Guerlet, Jean-Paul; Lehr, Pierre (CNRS, Val-de-Marne, France). Compt. Rend., Ser. C, 264: 1833-6(June 5, 1967). (In French).

At 600 to 850°C, CO is an oxidizing agent for Zr, and the kinetics are controlled by the mechanisms of diffusion of the O_2 through the surface layer of Zr and into the underlying metal. By contrast, at high temperatures the reaction leads to the formation of carbide and oxycarbide phases. (tr-auth)

32831 THE REACTION OF PURE CARBON DIOXIDE WITH URANIUM MONOCARBIDE: INFLUENCE OF THE TEMPERATURE. Moreau, Claude; Philippot, Joseph (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. C, 264: 1847-50(June 5, 1967). (In French).

The behavior of a solid mass of UC in pure anhydrous CO_2 was studied at 500 to 1200°C under a gas pressure of about 1 bar. It was possible to obtain durability and high oxidation ratios without producing disintegration of the sample. It was noted that the reactivity of this material in CO_2 is very slight. At 500 to 900°C, the oxidation law is linear with an activation energy of 17,000 cal/mole, which remains constant in spite of a slowing of the reaction around 650°C. Above 1000°C the normal rate of reaction becomes parabolic, and the activation energy reaches a value of 42,500 cal/mole. (tr-auth)

32832 HIGH TEMPERATURE OXIDATION OF Be-ELINVARS. Narita, Toyota; Tsuji, Yasunobu (Citizen Watch Co., Tokorozawa, Japan). Nippon Kinzoku Gakkaishi, 31: 109-13(1967). (In Japanese).

An attempt was made to identify oxides on 0 to 2.5 wt % Be-elinvars at 800 and 1100°C in dissociated ammonia gas and in air using electron and x-ray diffraction methods. An x-ray microanalyzer and an optical microscope were employed complementally in the observation of the oxides. BeO was formed selectively on the surfaces of 0.5 to 2.5 wt % Be-elinvars heated in a dissociated-ammonia gas at 800 and 1100°C for a few minutes. On the surfaces of 1.2 to 2.5 wt % Be-elinvars heated in air at 1100°C for 1 hour, BeO was formed predominantly. The surfaces of 0 to 1.2 wt % Be-elinvars exposed in air at 1100°C for 1 hour were covered with layer oxides—α-Fe_2O_3 (outer layer), spinel type oxide or $(Fe,Ni,Cr)_3O_4$ (inner layer). A thin $BeCr_2O_4$ film, in the same condition as above, spread itself on the surface of 2.5 wt % Be-elinvar, in pores of which the patches of oxides with layer structures were dispersed. (auth)

32833 BREAKAWAY PHENOMENON DURING OXIDATION OF MILD STEEL. Price, W. R.; Whittle, I. (Berkeley Nuclear Labs., Eng.). J. Iron Steel Inst., (London), 205: 668-70(June 1967).

A mechanism is proposed for breakaway oxidation of mild steels in CO_2 atmospheres containing CO and water vapour. It is suggested that carbon, deposited in the oxide from the reaction of iron with CO, then reacts with water vapour to produce a mixture of hydrogen and CO gas at the metal/oxide interface. It is shown from thermodynamic considerations that the amount of CO produced is sufficient to cause mechanical breakup of the oxide. (auth)

32834 INFLUENCE OF THE SURFACE QUALITY ON THE LIQUID SODIUM CORROSION OF NICKEL ALLOYS. Borgstedt, H. U.; Drechsler, G.; Frees, G. (Kernforschungszentrum, Karlsruhe, Ger.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-85/12, 16p. (CONF-661110-15). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna.

The effects of various surface qualities on liquid Na corrosion of two types of Inconel X was studied at 500 to 600°C after five different metal finishing methods were used to obtain defined surfaces of the alloys. The test coupons were annealed at 1050°C, and the surface treatments used were pickling with HNO_3, electropolishing in an H_3PO_4/H_2SO_4 mixture, grinding with grit paper 600, sandblasting, and mechanical polishing. All methods except pickling resulted in a metal surface of very low roughness. The corrosion rates and their dependence on temperature were found to be strongly influenced by the quality of the specimen surfaces. At 500°C measured reaction rates were found to have a higher positive value after mechanical polishing than after chemical finishing, but the reverse result was noted at 600°C. In all cases, the mechanically treated metal specimen had a higher temperature dependence than the chemically finished ones. This behavior can be explained as a consequence of the formation of a Beilby layer during mechanical finishing. Studies of the mass transfer products were also carried out. (B.L.M.)

Preparation and Fabrication

Refer also to abstracts 33835, 34100, 34168, 34178, and 34179.

32835 (AAEC/TM-361) TUNGSTEN PICK-UP DURING INERT GAS WELDING OF ALUMINIUM. Chrimes, N. W. D. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nov. 1966. 21p. Dep.

During the W inert gas welding of Al, small amounts of the electrode material are transferred to the weld pool. W impurities of the order 10 to 100 ppM are generally present and contents of this order cannot usually be detected radiographically. Possible methods of W transfer are discussed. (auth)

32836 (ARC-CP-811) CHEMICAL CONTOURING OF 3 PERCENT CHROMIUM–MOLYBDENUM–VANADIUM AND 5 PERCENT CHROMIUM–MOLYBDENUM–VANADIUM HIGH-STRENGTH STEEL SHEET. (Bristol Aerojet Ltd., Banwell (England)). Mar. 1964. 49p. Dep. CFSTI. UK 9s. 6d.

Processes developed for chemical contouring of high-strength Cr–Mo–V sheet steel are described. Techniques for preparing test panels are outlined and etchants and maskants are evaluated. It was determined that etch rate was affected by previous heat treatment of the steel, was somewhat erratic from one batch of steel to another, and that etching temperature was critical. The most promising etchant for RS130, RS140, and H50 steels was composed of 20% HNO_3, 5% H_3PO_4, and 5% H_2SO_4, but it was concluded that none of the etchants developed could be classed as universal. (P.G.C.)

32837 (BM-RI-6894) SOLID-STATE ELECTROMIGRATION OF IMPURITIES IN CERIUM METAL. Marchant, Jack D.; Shedd, E. S.; Henrie, T. A. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). July 1966. 17p.

Ce metal in bars 6 in. long and ½ in. in dia was refined at 600°C by solid-state electrolysis to remove Fe, Cu, and Mn. Fe and Mn were electrotransported to the anode and Cu was electrotransported to the cathode. The concentration of Fe at the anode of a Ce bar was greater than the concentration at the cathode. The concentration of Mn at the anode was higher than at the cathode. The concentration of Cu was greater at the cathode than at the anode. A radiotracer technique was used to follow the Fe migration in the Ce metal. Mo, Si, and Al impurities were not electrotransported. (auth)

32838 (BM-RI-6964) COLUMBIUM AND TANTALUM ALLOY DEVELOPMENT. Babitzke, H. R.; Kato, H. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Nov. 1966. 23p.

Nb and Ta were combined with W, Hf, Zr, Mo, V, and Ti, and the resulting alloys were evaluated with respect to workability, hardness, electrical resistivity, strength at elevated temperatures, oxidation resistance, and weldability. Nb–33Hf–10W–10Ti; Nb–20Hf–5Mo, and Nb–30Hf–5Mo exhibited superior high temperature properties. Nb–33Hf–10W–10Ti had tensile strength values of 44,300 psi at 1,200°C and 16,500 psi at 1,400°C, Nb–20Hf–5Mo had values of 35,700 and 20,700 psi, respectively. The

corresponding values for Nb–30Hf–5Mo were 38,900 and 17,800 psi. These alloys are fabricable by conventional methods with excellent strength at temperatures up to and including 1,400°C. An oxidation rate of 7 to 21 mg/cm²/hr was observed up to 1,000°C. (auth)

32839 (EURAEC–1812) STAINLESS STEEL CLADDING OF HEAVY GAGE STEELS. Quarterly Report No. 9, July 1–September 30, 1966. (Soudometal, S. A., Brussels (Belgium). Ghent Rijksuniversiteit (Belgium). Neratoom, N. V., The Hague (Netherlands)). Contract 008-63-12TEEB(RD). 23p. (EUR–3348). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Progress on experiments designed to weld stainless steel cladding on 30 mm thick, low-C steel plates is reported. Factors discussed are welding and electric parameters, fluxes, composition of welding bands, and results of chemical analyses of weld deposits. (P.G.C.)

32840 (IS-RIC–1) COMPILATION OF RARE-EARTH PRODUCTS AVAILABLE FROM COMMERCIAL SUPPLIERS. Smith, Joan E.; Gschneidner, K. A. Jr. (Ames Lab., Iowa). Feb. 1967. Contract W-7405-eng-82. 216p. Dep. CFSTI.

The suppliers of rare earth products, the products, purities, and prices are listed. The data are organized in the following 6 categories: metals, alloys, compounds, mixtures, solutions, and special products. (M.C.G.)

32841 (K-L–6130-2) VAPOMETALLURGY: PRESENT TECHNOLOGY AND SOME FUTURE ASPECTS. Smiley, S. H.; Merriman, J. R. (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1967]. Contract W-7405-eng-26. 24p. Dep. CFSTI.

The technology of vapometallurgy is reviewed on the basis of recent work conducted by several research organizations. Programs discussed include production of coated particle fuels, vapor-deposited W alloy tubing, deposition of metal carbides, boron nitride, high-purity Cr and Ti, metal/ceramic/metal strutures, cladding for thermionic converters, W alloys, fibers, whiskers, and dispersion-strengthened materials. Forty-eight pertinent references are listed. (P.G.C.)

32842 (K-L–6151) ECONOMIC ANALYSIS OF FLUORINATION PROCESSES FOR THE RECOVERY AND RECYCLE OF VALUABLE CVD MATERIALS. Smiley, S. H.; Pashley, J. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1967]. Contract W-7405-eng-26. 23p. (CONF-670905–1). Dep. CFSTI.

For Presentation at Conference on Chemical Vapor Deposition of Refractory Metals, Gatlinburg, Tenn.

High-purity metal fluoride feed stocks to be used directly for chemical vapor deposition of shapes and coatings or to prepare special refractory metal and alloy powders can be easily produced by direct fluorination. It is estimated that the cost for reconverting 400 pounds per day of W-25% Re alloy from scrap to prealloyed powder via fluorination and flame reduction is about $28 per pound of contained-Re, a small fraction of the current market value of this metal. (auth)

32843 (K-L–6156) PREPARATION OF UNUSUAL REFRACTORY POWDERS BY FLAME PROCESSES. Merriman, J. R.; Smiley, S. H.; Kaufman, H. L. (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1967]. Contract W-7405-eng-26. 28p. (CONF-670905–4). Dep. CFSTI.

For Presentation at Conference on Chemical Vapor Deposition of Refractory Metals, Gatlinburg, Tenn.

The preparation of refractory metal and alloy powders by the hydrogen-fluorine chemical flame process is described. Major emphasis was on the production of W–Re alloy powders. Other powders prepared and described are: W–Mo–Re; Tc; and W–Tc alloy powders. The application of other flames as energy sources for reduction processes is discussed. (P.C.H.)

32844 (NASA-SP–5062) HIGH-VELOCITY METALWORKING. A Survey. Noland, Michael C.; Gadberry, Howard M.; Loser, John B.; Sneegas, Eldon C. (Midwest Research Inst., Kansas City, Mo.). 1967. 194p. GPO $1.25.

A comprehensive survey of high-energy-rate metalworking techniques is presented. Topics covered are shaping by electromagnetic, electrohydraulic, pneumatic-mechanical, and explosive methods, forging and welding, explosive hardening, design of dies and tools, and metal behavior at high strain rates. An extensive bibliography is included. (P.G.C.)

32845 (ORNL–P–3102) APPLICATION OF CHEMICAL VAPOR DEPOSITION TO THE PRODUCTION OF TUNGSTEN TUBING. Martin, W. R.; Heestand, R. L.; McDonald, R. E.; Reimann, G. A. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 25p. (CONF-670905–3). Dep. CFSTI.

For Presentation at Conference on Chemical Vapor Deposition of Refractory Metals, Gatlinburg, Tenn.

The direct process of chemical vapor deposition for producing tungsten tubes for further working or tubing in its final form is discussed. The as-deposited structure of the chemical vapor-deposited W may be sufficient and/or desirable for some specific applications. Simple shapes such as tubing in lengths up to nearly 4 ft can be made easily and are less expensive than equivalent tubing made by the conventional extrusion-drawing method. Such tubes can be made in various dia with wall thickness variations not exceeding ±0.001 in. in the as-deposited condition. Therefore, this method is attractive for making shorter lengths of tubing of higher purity (less than 25 ppM total metallic impurities). If the as-deposited structure of chemical vapor-deposited W is undesirable, tube shells for further working can be made by chemical vapor deposition. These tube shells can be worked conventionally, as by extrusion and drawing. The microstructure of chemical vapor-deposited material after working is comparable to that of arc-cast or powder-metallurgy products. If the amount of drawing is reduced to a few passes, the cost of worked chemical vapor-deposited tubing would be less than that of conventional tungsten tubing. (auth)

32846 (RSIC–601) MAKING OF STAINLESS STEEL SHAPES BY CASTING AND POWDER METALLURGY. Kura, J. G.; Barth, V. D.; Hall, E. T.; Safranek, W. H.; McIntire, H. O. (Battelle Memorial Inst., Columbus, Ohio). Feb. 16, 1967. Contract DA-01-021-AMC-11651(Z). 218p. (NASA-TM-X-53577).

The state of the art of making shapes of stainless steel by casting and by powder metallurgy methods is reviewed. Use of stainless steel powders to make parts is increasing rapidly. Chemical vapor deposition and electroforming were considered in the study but they are not being used for making stainless steel parts. (auth)

32847 FIRST YUGOSLAV PILOT-PLANT FOR THE CONTINUOUS PRODUCTION OF URANIUM METAL AND URANIUM DIOXIDE. Milosavljevic, Jovan (Instituta za Tehnologiju Nuklearnih i Drugih Mineralnih Sirovina, Belgrade); Filipovic, Mirjana; Krstic, Dimitrije. Nukl. Energ., 4: No. 1, 12-18(1967). (In Slovak).

The Institute for Technology of Nuclear and Other Raw Materials in Beograd has erected and put in operation the first Pilot Plant for the production of reactor grade U metal, and ceramic grade UO_2, from nuclear grade $NH_4(UO_2)_2$. After a careful analysis of its performance, and its potential capabilities, it has been estimated that the plant with an additional investment not higher than 20% of its value, could operate on a large scale with an annual capacity of 50 tons of U metal, or 120 tons of UO_2 minimum. Such a high capacity, with respect to the UO_2, is obtained on account of the special design characteristics of the horizontal tubular furnace system, capable of producing either dioxide, or green salt, which is directly reduced to U metal. The economical parameters obtained during the two-year experimental work, show that either metal, or dioxide could be produced at the competitive prices. (auth)

32848 ON THE PLATING OF STEEL TUBES WITH ZIRCALOY-2 TUBES BY SWAGING. Brutto, Eliano (CISE, Milan); Perona, Giovanni; Volta, Giuseppe. Z. Metallk., 58: 487-90 (July 1967). (In German).

The processes occurring during swaging of two tubes of steel and Zircaloy-2 for diffusion welding were studied and analyzed. A mathematical treatment of problems of this kind is proposed and the results are compared with practical observations. (auth)

32849 CESIUM DEPOSITION ON STAINLESS STEEL. Milstead, C. E.; Zumwalt, L. R. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-167. Nucl. Appl., 3: 495-9(Aug. 1967).

The deposition of Cs on type-304 stainless steel has been measured in vacuo using ^{137}Cs-tagged Cs. Measurements were made at 650 to 1350°F over a Cs pressure range of 2×10^{-9} to 5×10^{-6} atm using specimens that had been vacuum baked at temperatures ranging from 650 to 1870°F for 18 to 90 hr. Adsorption isotherms were characterized by an empirical isotherm that shows a linear variation of log pressure with surface coverage; the heat of sorption decreases linearly with coverage. Cs plateout levels range from 0.55 mg Cs/m² (based on the geometric surface of the specimen) on very clean surfaces to 80 mg Cs/m² on surfaces that were slightly oxidized. The amount of Cs deposited is shown to be directly related to the temperature and duration of the bakeout period. Isosteric heats of adsorption vary from about 22 to 98 kcal/mol over the range of coverage. (auth)

32850 MAGNESIOTHERMAL PROCESS FOR THE PREPARATION OF METALLIC URANIUM. Huet, H.; Lorrain, Ch. Energ. Nucl. (Paris), 9: 181-8(May 1967). (In French).

The production of U is an important element which must not be

neglected in the race for competition in the atomic energy field. The replacing of Ca by Mg, during the main production phase, results in a substantial decrease in the cost of the metal. A new process for reduction of tetrafluoride to metal such as was done at the C.E.A. Center at Le Bouchet is described, and its advantages are compared with those of the calciothermal process. (auth)

32851 TUNGSTEN–RUTHENIUM ALLOYS. (to U. S. Atomic Energy Commission). British Patent 1,070,114. May 24, 1967. Priority date June 21, 1965, United States.

An alloy of W and Ru was developed which had greater tensile strength and hardness than W, but was more susceptible to oxidation. (P.G.C.)

32852 BONDED METALLIC AND METALLIZED NON-METALLIC MEMBERS. (to U. S. Atomic Energy Commission). British Patent 1,071,115. June 7, 1967. Priority date Oct. 28, 1963, United States.

A new process for bonding assemblies of metals and ceramics is reported. Typical combinations are stainless steel or Cu brazed to Al_2O_3, BeO, TiO_2, ZrO_2, or single crystals of Ge or Si. Although the individual components have different coefficients of expansion the assemblies are thermally stable over a wide temperature range and are crack resistant. Anticipated uses are for thermoelectric devices and in miniaturization. (P.G.C.)

32853 PROCESS FOR WELDING OR BRAZING TWO MEMBERS OF WHICH AT LEAST ONE IS MADE OF GRAPHITE. Guichet, Lucien Robert; Gotoghian, Georges Jacques (to Societe Nationale d'Etude et de Construction de Moteurs d'Aviation). British Patent 1,071,179. June 7, 1967. Priority date Dec. 17, 1962, France.

A procedure is described for welding or brazing two members of which one at least is graphite. In the process a bonding layer of a powdered mixture of one or more refractory metals, Hf, Mo, Nb, Ta, Ti, W or Zr, or their borides, carbides, or nitrides is interposed between the members to be welded and the assembly is heated at 2000 to 3000°K in vacuum or in controlled atmosphere. The welded assembly resists tension or shearing better than graphite and will withstand temperatures of the order of 2800°K. The technique has applications in fabrication of rocket nozzles and reactor parts. (P.G.C.)

Properties Evaluations

Refer also to abstracts 32838, 32851, 32853, and 32963.

32854 (AERE-Bib–155) WETTING OF ALUMINIUM OXIDE AND OTHER OXIDES BY LIQUID METALS. Jones, P. J. (comp.) (Atomic Energy Research Establishment, Harwell (England)). May 1967. 10p. Dep. CFSTI. UK 1s. 9d.

A bibliography of 66 references is presented. Sources are Chemical Abstracts, Nuclear Science Abstracts, Scientific and Technical Aerospace Reports, and British Ceramics Abstracts. (UK)

32855 (AGN–8191(Vol.5)) ALKALI METALS EVALUATION PROGRAM. VISCOSITY OF LIQUID SODIUM AND LITHIUM. Achener, P. Y.; Fisher, D. L. (Aerojet-General Corp., San Ramon, Calif. Nuclear Products and Services Group). May 1967. Contract AT(04-3)-368. 49p. Dep. CFSTI.

Viscosity of liquid Na and Li at temperatures from the melting points to 1040 and 878°C, respectively, are reported. The experimental method involved the use of an oscillating cylinder viscometer. The equations proposed for the absolute viscosity of Na and Li are, respectively: $\log_{10}\mu = 3.25538 - 10.4126/T - 0.96843 \log_{10}T$ and $\log_{10}\mu = 1.310 + 225.4/T - 0.3478 \log_{10}T$, where μ is in millipoises and T in degrees Kelvin. (auth)

32856 (BM-RI–6988) STUDY OF COLUMBIUM-BASE ALLOYS. Yoda, Renpei; Babitzke, H. R.; Kato, H. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). July 1967. 40p.

An investigation was conducted to develop Nb alloys with elevated-temperature strengths higher than those exhibited by more common commercial Nb alloys, and attention was given to improving the oxidation resistance and ease of fabrication. Additions of C, Al, and Cr were made to some Nb-base alloys, and their effects on workability, recrystallization, oxidation resistance, and mechanical properties at elevated temperatures were explored. The additions were made to take advantage of solid-solution strengthening and precipitation hardening. Three alloys displayed good high-temperature properties with relatively good oxidation resistance at 1,000°C, and tensile strengths from 26,000 to 32,200 psi at 1,400°C. When the properties of these alloys were compared with those of commercial alloys, B-66 and FS-85 (3), the outcome was favorable for the alloys studied in this investigation. (auth)

32857 (BNL–11530) COBALT-BASE ALLOY TESTING PROGRAM. Herchenroeder, R. B. (Brookhaven National Lab., Upton, N. Y.). Apr. 21, 1967. Contracts AT-30-2-GEN-16; 103423. 64p. Dep. CFSTI.

Various Co-base alloy compositions were evaluated as potential fast-reactor fuel cladding materials. Cr-containing and Cr-free alloys were modified with varying amounts of Mo, Nb, V, Zr, Ti, and Hf. These were evaluated with respect to hot-working characteristics, stress rupture properties at 1500°F, weldability, and ductility (via room temperature tensile tests). Results indicate that alloys containing Ti offer the best opportunity for achieving the strength goals of the program without detrimental side effects. (auth)

32858 (BNWL–421) REACTIONS OF SELECTED METAL–METAL COUPLES AT 1100°C. Kirby, L. J.; Fullam, H. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1967. Contract AT(45-1)-1830. 20p. Dep. CFSTI.

Metal-metal couples were studied after exposures up to 4000 hr at 1100°C to characterize and evaluate the reactions that occurred. The couples studied included Hastelloy X, Ta, 304L stainless steel, Re, and Pt with metals and metal couples. The reactions of Hastelloy X and Hastelloy C with Re, W/25 Re, and Ta were studied following experiments where the temperature was cycled (700 to 1100°C). The slightly different behaviors of Hastelloy X, Hastelloy C, and 304L stainless steel in reactions with potential capsule liners suggested that minor alloy constituents play important roles in limiting the net diffusion of the couples. Other results are also discussed, and data are tabulated. (P.C.H.)

32859 (LA–3545) BEHAVIOR OF LIQUID Pu–Co–Ce ALLOYS IN CONTACT WITH SODIUM. II. LIQUID METAL EQUILIBRIA. Clifford, J. C. (Los Alamos Scientific Lab., N. Mex.). Apr. 15, 1967. Contract W-7405-eng-36. 10p. Dep. CFSTI.

Na was equilibrated with Ce, Pu, Co–Ce, and Pu–Co–Ce in capsules of Ta or Ta – 5W alloy. Ce/Na equilibrations were conducted at 825°C, and the others at 700°C. In all experiments involving Ce as a component, the equilibrium concentration of Ce in the Na was ≤ 4 ppM. Corresponding values for Co were ≤2 ppM. The solubility of Pu in Na is ≤2 ppM at 700°C. Because of a program reorientation, the experiments were not extended to other temperatures. (auth)

32860 (LA-DC–8539) STRESS WAVE PROFILES IN SEVERAL METALS. Taylor, John W. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 33p. (CONF-670513–5). Dep. CFSTI.

From Colloquium on Dislocation Dynamics Conference, Seattle, Wash.

A series of measurements, by the d-c capacitor technique, of the free-surface velocity profiles of various metals which were subjected to impact loads by gas- and propellant-fired projectiles is given. Usually the collisions were between symmetric materials. Collision planarities were controlled so as to be simultaneous over the measuring area typically to within 0.02 μsec or less. (W.D.M.)

32861 (ORNL–TM–1810) MODEL FOR COMPUTING THE MIGRATION OF VERY SHORT-LIVED NOBEL GASES INTO MSRE GRAPHITE. Kedl, R. J. (Oak Ridge National Lab., Tenn.). July 1967. Contract W-7405-eng-26. 26p. Dep. CFSTI.

A model describing the migration of very short-lived noble gases from the fuel salt to the graphite in the MSRE core was developed. From the migration rate, the model computes (with certain limitations) the daughter-product distribution in graphite as a function of reactor operational history. Noble gas daughter-product concentrations (^{140}Ba, ^{141}Ce, ^{89}Sr, and ^{91}Y) were measured in graphite samples removed from the MSRE core after 7800 Mwhr of power operation. Concentrations of these isotopes computed by this model compared favorably with the measured values. (auth)

32862 (ORNL–TM–1826) FRACTURE OF Al–Al_2O_3 ALLOYS: FRACTURE ANALYSIS OF THE COMMERCIAL SAP-TYPE ALLOY XAP-001. Harman, D. G.; Nolan, T. A. (Oak Ridge National Lab., Tenn.). July 1967. Contract W-7405-eng-26. 18p. Dep. CFSTI.

Fracture surfaces of XAP-001 dispersion-hardened Al were examined in the electron microscope using two-stage replication. The fracture surfaces were obtained from rod tensile specimens tested at –200 to 450°C or creep tested at 450°C. Three modes of ductile fracture are described and identified by fractography. High-temperature fractures are initiated as single oxide particles or groups of particles. Banding and stringering of oxide particles seriously affect the fracture process. (auth)

32863 (ORNL–TM–1861) THE TEMPERATURE AND TIME DEPENDENCE OF THE HARDNESS OF IRON AND NICKEL. Larsen-Badse, J. (Oak Ridge National Lab., Tenn.). July 1967. Contract W-7405-eng-26. 25p. Dep. CFSTI.

Vickers hardness testing was carried out on Armco iron and pure Ni at 400 to 800°C. The load was 1 kg and the time of loading was varied between 15 sec and 1 hr. The hot-hardness values were shown to be most easily analyzed by considering them to consist of a temperature-dependent and a time-dependent contribution. The temperature-dependent part is intimately related to the flow stress of the material while the time-dependent part is a function of the creep properties. Activation energies for indentation creep as well as the exponent of stress dependence of the creep strain rate at low stresses can be determined rapidly from hot-hardness data. (auth)

32864 (ORO-2430-38) X-RAY ANALYSIS OF STRESS IN THIN GOLD FILMS. McDowell, Blake (Duke Univ., Durham, N. C. Dept. of Electrical Engineering). Apr. 1967. Contract AT(40-1)-2430. 100p. Dep. CFSTI.

A general x-ray diffraction analysis was formulated to study strain in thin films. This formulation makes three basic assumptions: the existence of a relatively unstrained reference; a large number of crystallites within the incident x-ray beam; and the strain varies only in a direction normal to the surface. Bulk gold was used as the reference because of the accurate correspondence of the off-annealed films' peak shapes to those of bulk. The second assumption was confirmed by an electron microscope examination which showed that at least 2.5×10^8 crystallites were within the diffracted beam. The justification of the third assumption was the accuracy with which the data corresponded to the formulation. The results of linear and non-linear analyses are discussed. (auth)

32865 (UCRL-17470) INVESTIGATION OF THE APPLICATION OF SPINODAL THEORY TO THE PALLADIUM-IRIDIUM SYSTEM. Walter, Gordon (California Univ., Berkeley. Lawrence Radiation Lab.). May 1967. Contract W-7405-eng-48. 38p. Dep. CFSTI.

Thesis.

Hardness, microstructural, and x-ray observations of a 56 at. % Pd-44 at. % Ir alloy were made to investigate the applicability of existing spinodal theory. Specimens of the Pd-Ir alloy were aged at temperatures well below the critical temperature predicted by existing theory. Classic spinodal decomposition was not found to occur in any of the studies even though specimens were aged long times. A theoretical justification is offered for this phenomenon. The modification of existing spinodal theory is based on effects of differing elastic moduli of the alloy components. Pd and Ir are excellent metals for such a study because the elastic modulus of Ir is nearly five times that of Pd. (auth)

32866 (UCRL-70340(Pt.2)) CVD TUNGSTEN AND TUNGSTEN-RHENIUM ALLOYS FOR STRUCTURAL APPLICATIONS. PART II. EVALUATION. Holman, William R.; Huegel, Frank J. (California Univ., Livermore. Lawrence Radiation Lab.). June 16, 1967. Contract W-7405-eng-48. 25p. (CONF-670905-6). Dep. CFSTI.

From Conference on Chemical Vapor Deposition of Refractory Metals, Gatlinburg, Tenn.

The effects of deposition variables and heat treatments on the room temperature mechanical properties of CVD W and W-Re alloy tubing were determined. Tubes selected from the process-development program were sectioned into small ring-shaped specimens, heat-treated, and tested to failure in uniaxial tension. Yield strength, ultimate tensile strength, and uniform elongation were determined with a hydraulic ring tester developed specifically for this application. Tensile strengths as high as 150,000 psi were obtained with unalloyed W deposits. Measurable ductility was observed in a fine-grain deposit after a stress relief anneal at 1000°C. Ultimate tensile strengths exceeding 200,000 psi and uniform elongations as high as 2% were obtained with co-deposited W-Re alloys. The results indicate that deposits with mechanical properties approaching those of wrought material can be obtained by chemical-vapor deposition. (auth)

32867 (LA-tr-67-55) STATISTICAL-MECHANIC INTERPRETATION OF THE SOLUBILITY ISOTHERM OF HYDROGEN IN HYDRIDE PHASE FOR THE METALS PALLADIUM, VANADIUM, NIOBIUM, AND TANTALUM. Bucur, R. V.; Crisan, M. Translated by Rose Mary Boicourt (Los Alamos Scientific Lab., N. Mex.), from J. Phys. Chem. Solids, 28: 995-1000(1967). 9p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

A statistical-mechanic interpretation of the phenomenon of H dissolution in the hydride phase is presented for the metals Pd, V, Nb, and Ta on the basis of a model that assumes association of atoms in pairs in the vacant sites of the lattice and perfect solid solution behavior. The equation of the solubility isotherm (Langmuir type) thus deduced can be verified experimentally. (auth)

32868 (WAPD-Trans-54) EFFECT OF TUBE EXPANSION ON THE STRESSES AND RIGIDITY OF HEAT EXCHANGER PLATES. Tran-Huu-Hanh (Ecole Nationale Superieure de Mecanique, Nantes (France)). Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from the 1966 Annals. 26p. Dep. CFSTI. JCL $2.60 fs, $0.98 mf.

Calculated and measured stresses existing in steel heat exchanger plates, perforated with expanded tubes, are described. Aspects analyzed include induced stresses due to expansion, effect of tubes on rigidity, distribution of stresses, residual stresses, and deflections. (P.G.C.)

32869 TRANSFORMATION AND DEFORMATION IN PLUTONIUM. Nelson, R. D.; Bowman, F. E.; Bierlein, T. K. (Pacific-Northwest, Richland, Wash.). pp 1-17 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22-26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Results of an investigation on the differences in the structure and properties of high-purity β-phase Pu, formed from alpha (β_α) and formed from gamma (β_γ), are reported. Marked differences in tensile strengths, ductilities, and creep strengths are noted. The parent beta phase, whether formed from alpha or gamma, is considered to be an important parameter affecting deformation of specimens during the $\beta \rightarrow \alpha$ transformation under both compressive and tensile stresses. Data on the transformation kinetics, alpha microstructure, and crystallography of β_α and β_γ are presented. An explanation of the observed differences is advanced. (auth)

32870 PHYSICAL PROPERTIES OF α-PLUTONIUM AND δ-PHASE ALLOYS AT LOW TEMPERATURES. Lallement, R.; Solente, P. (CEN, Fontenay-aux-Roses, France). pp 147-61 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22-26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Low-temperature lattice parameter measurements on α-Pu and δ-Pu are presented. An interpretation of these experiments is given, taking into account previous measurements of Young's modulus and resistivity under pressure and it was concluded that α-Pu undergoes a second-order transition around 50°K. The change in length of α-Pu at 4 and 77°K was measured as a function of time. This phenomenon is explained adequately by self-damage induced defects. (auth)

32871 SOME PHYSICAL PROPERTIES OF PLUTONIUM AT LOW TEMPERATURES. Taylor, J. C.; Loasby, R. G.; Dean, D. J.; Linford, P. F. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 162-75 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22-26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Specific-heat and elastic-constant measurements for α-phase Pu metal and a series of δ-phase alloys over the temperature range from 20 to 600°K are presented. Below room temperature both properties show a smooth temperature dependence with no evidence to indicate the existence of any ordering phenomena in either the α or δ-phases of the metal. Analysis of the α-phase data showed an anomaly in the electronic specific heat in the region of 40°K, which is of a similar form to that expected from a Schottky event. The addition of both Al and Ce to the δ-phase of results in an increase in elastic moduli, which is most marked in the Pu-Al system. Extrapolation of the data gives values of 2.1×10^{11} and 1.4×10^{11} dynes/cm^2 for the Young's modulus of the unalloyed δ-phase at 320 and 420°C, respectively. (auth)

32872 SOME PHYSICAL PROPERTIES OF PLUTONIUM METAL AT LOW TEMPERATURES. Lee, J. A. (Atomic Energy Research Establishment, Harwell, Eng.); Marples, J. A. C.; Mendelssohn, K.; Sutcliffe, P. W. pp 176-88 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22-26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Recent lattice-parameter and specific-heat measurements on high-purity Pu provide evidence of the change of state at ~60°K and support the hypothesis that α-phase Pu orders magnetically in this region. The results are reported briefly. (auth)

32873 MAGNETIC SUSCEPTIBILITY OF THE MONOCARBIDES OF URANIUM AND PLUTONIUM. Lam, D. J.; Nevitt, M. V.; Ross, J. W.; Mitchell, A. W. (Argonne National Lab., Ill.). pp 274-85 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22-26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The magnetic susceptibility of UC and nonstoichiometric PuC was measured in the region from 5 to 400°K. The values for UC are in good agreement with those of Bates and Unstead. The constant susceptibility may be explained either on the band model, chosen by Bates and Unstead, or from a localized electron point of view, which incorporates crystal field splitting of the lowest J multiplet of the U^{4+} ion. All three PuC compounds showed a marked deviation from Curie–Weiss behavior: there was a maximum susceptibility at 20°K in each compound. As with UC a qualitative explanation can be formulated in terms of a band or localized electron model. If the band type is chosen, antiferromagnetism must be invoked to explain the peak in the susceptibility. A similar argument pertains if the lowest-lying electronic state due to crystal field splitting, possesses a permanent magnetic moment. However, there is a pronounced similarity between the experimental results and the susceptibility calculated with Γ_1 as the lowest lying state of the Pu^{4+} ion. The overall crystal-field splitting of the $^5I_4$ state is assumed to be approximately 400°K. (auth)

32874 VISCOSITY-DENSITY-COMPOSITION RELATIONSHIPS FOR LIQUID PLUTONIUM–CERIUM ALLOYS. Ofte, Donald; Rohr, William G.; Wittenberg, Layton J. (Monsanto Research Corp., Miamisburg, Ohio). pp 405-19 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Viscosity–density–composition relationships were established for molten Pu–Ce binary alloys and Pu–Ce–Co ternary alloys. The viscosities of the alloys were measured by an absolute method in an oscillating cup viscosimeter and the liquid densities were measured by a vacuum pycnometric method. The viscosity function for 11 liquid Pu–Ce alloys between 0 and 100 at. % Ce and 4 Pu–Ce–Co ternary alloys decreased linearly with increasing temperature when log (η/T), η in poise, was plotted as a function of reciprocal absolute temperature (1/T). A maximum in viscosity at 4.9 at. % Ce and a viscosity minimum at 14 at. % Ce were noted in the Pu–Ce system. Continuously increasing viscosities were noted when Pu was substituted for Ce at constant Co concentration in the Pu–Ce–Co alloys. The highest viscosity recorded, 23 centipoise, was unusually high for a liquid-metal system. The liquid densities of the ternary alloys showed the expected increase when Pu was substituted for Ce. Liquidus temperatures were measured, under conditions of thermal equilibrium for the binary and ternary alloys with the viscosimeter. In the Pu–Ce binary system the liquidus temperature measurements revealed a smooth liquidus profile. (auth)

32875 STATUS OF METALLIC PLUTONIUM FAST POWER-BREEDER FUELS. Kelman, L. R.; Savage, H.; Walter, C. M.; Blumenthal, B.; Dunworth, R. J.; Rhude, H. V. (Argonne National Lab., Ill.). pp 458-84 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Pertinent out-of-pile metallurgical developments that lead to Pu fast reactor fuel alloy programs at ANL are described. Of particular interest is the recent development of U–Pu–Zr and U–Pu–Ti alloys with solidus temperatures above 1100°C and the discovery that the U–Pu–Zr alloys are compatible with Type 304 stainless steel to at least 800°C. The significance of these developments is discussed. Also the results of fuel/cladding compatibility studies as well as studies of solidus temperatures, structures, and pertinent properties of U–Pu-based alloys are reviewed. The Th–U–Pu alloys were investigated as part of the search for high-melting alloys with good irradiation resistance. The relevant features of the ternary phase diagram were determined, and it was found that only a limited range of compositions with 10 to 20% U and 10% Pu has solidus temperatures above 900°C. For these alloys the pertinent metallurgical properties were determined. (auth)

32876 A STUDY OF PLUTONIUM-BASED ALLOYS CARRIED OUT AT FONTENAY-AUX-ROSES. Boucher, R.; Barthelemy, P.; Milet, C. (CEN, Fontenay-aux-Roses, France). pp 485-509 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The fabrication, structure, phase transformations, expansion coefficients, thermal cycling, and atmospheric corrosion behavior of various Pu alloys were studied. The principal properties of U–Pu–Mo, U–Pu–Nb, U–Pu–Ti, and U–Pu–Zr alloys and the U–Pu–Fe alloys for the critical experiment MASURCA are described. Initial results on U–Pu–C–Mo, U–Pu–C–Ti, and U–Pu–C–Zr alloys are reported. (auth)

32877 METALLIC PLUTONIUM ALLOYS FOR FAST CRITICAL EXPERIMENTS. Kelman, L. R.; Rhude, H. V.; Schnizlein, J. G.; Savage, H. (Argonne National Lab., Ill.). pp 510-24 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Ind., 1967.

See CONF-651102.

Developments are summarized of studies of U–Pu-base alloys that are intended to satisfy the requirements of zero power fuels for fast power-breeder critical experiments. An alloy containing 3 or 4 atoms of ^{238}U to one atom of ^{239}Pu is needed that will be versatile enough to permit mockup of a variety of U–Pu fuels. A limited amount of an acceptable third element may be added to impart the proper air corrosion and ignition resistance, metallurgical stability expansion characteristics, strength, ductility and fabricability. U–Pu alloys containing 6 at. % Mo were found to best satisfy these conditions. Other elements investigated as possible alloying additions were Al, C, Cu, Fe, Zr, V, and Ti. Of these other alloys only the U–Pu–Ti and U–Pu–Zr alloys had sufficient corrosion resistance to justify further study. Under some conditions, cast U–Pu–Fe alloys appeared to be satisfactory, but they were found to be sensitive to their fabrication and thermal history. Titanium and zirconium are preferred over molybdenum for physics reasons and are currently being investigated. Other pertinent properties of the best alloys are reviewed. (auth)

32878 FURTHER STUDIES ON THE DIFFUSION OF PLUTONIUM. Calais, D. (CEN, Fontenay-aux-Roses, France). pp 527-8 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Plutonium diffusion was studied by fusing two discs, one pure U and one a U-1% Pu alloy, together by pressing at 50 kg/mm² for 1 hr at 400°C followed by annealing for 2500 hr at 640°C, the temperature at which U recrystallizes following the cold work caused by the pressing. The Pu diffused intergranularly from the alloy into the pure U, and autoradiographic studies showed that the Pu was found in well-defined lines demonstrating that the grain boundary moved in a series of discontinuous steps. The self diffusion of ϵ-Pu was studied using couples of ^{239}Pu poor and rich in ^{240}Pu with the diffusion followed by scintillation counter detection of the x-ray spectrum from ^{240}Pu. The diffusion zone was found to be about 4 mm wide after 10 hr at 500°C, and the diffusion curve is reproduced. (B.L.M.)

32879 SOME OBSERVATIONS ON THE COMPRESSIVE CREEP BEHAVIOR OF A δ-STABILIZED PLUTONIUM 1 WT PERCENT GALLIUM ALLOY. Robbins, Jack L.; Wheeler, Alan D. (Univ. of California, Livermore). pp 543-57 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The compressive creep characteristics of a Pu–1 wt % Ga alloy were evaluated at a constant stress of 2000 lb/in.² over the temperature range 234 to 387°C. In all cases the true strain versus time curves manifested a predominantly tertiary type of behavior. This accelerating creep rate was not caused by internal cavity formation; rather, it was related to partial recrystallization and possibly an enhancement in the recovery processes. The apparent activation energy for creep was determined to be 33.7 ± 2.5 kcal/mole independent of strain between strain values of 0 and 0.15. (auth)

32880 STEADY-STATE CREEP OF PLUTONIUM. Nelson, R. D. (Pacific-Northwest, Richland, Wash.). pp 564-70 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Creep of the Pu allotropes was investigated with respect to temperature and stress. The creep rates of Pu allotropes formed by heating a low temperature stable allotrope decreased in the order of $\epsilon > \delta' > \delta > \beta > \gamma > \alpha$; but the order of β and γ creep rates of the allotropes formed by cooling a high-temperature, stable allotrope was reversed, i.e., $\epsilon > \delta' > \delta > \gamma > \beta > \alpha$. (auth)

32881 RATE OF SOLUTION OF ROTATING TANTALUM DISKS IN LIQUID TIN. Kassner, T. F. (Argonne National Lab., Ill.). J. Electrochem. Soc., 114: 689-94(July 1967).

The dissolution kinetics of Ta in liquid Sn were investigated under the well-defined hydrodynamic conditions produced by the rotating-disk sample geometry. Dissolution data were obtained under laminar flow conditions (Reynolds No. 1×10^3 to 1×10^5) at 800 to 1200°C. Much of the experimental data was found to be in a region of mixed transport control; however, for specific conditions of temperature and velocity, both limiting cases for reaction and diffusion control were also observed. The solubility of Ta in liquid Sn was determined at 600 to 1200°C. The diffusion coefficient of ^{182}Ta in liquid tin was also measured at 500 to 1100°C by the capillary-reservoir method. These data were used in the convective-diffusion model set forth by Levich to calculate values for the diffusion-controlled dissolution flux. The model was extended to include the range of Schmidt numbers between 4 and 1000. A Schmidt number of ~25 in the Ta–Sn system at 1200°C resulted in a 12% reduction in the calculated dissolution flux. Within the limits of error of the experimental diffusion data, the dissolution flux from the model was in agreement with the experimental values in the region of diffusion control. (auth)

32882 HEAT-TREATMENT OF ANODIC OXIDE FILMS ON TANTALUM. VI. THE EFFECT OF CHEMICAL THINNING. Smyth, Donald M. (Sprague Electric Co., North Adams, Mass.). J. Electrochem. Soc., 114: 723-5(July 1967).

The dielectric properties of anodized Ta, which was heat-treated in air, were studied as a function of subsequent chemical reduction of the oxide thickness. The results are in quantitative agreement with an exponential distribution of dielectric losses decreasing monotonically from the Ta–Ta_2O_5 interface. (auth)

32883 MATERIALS RESEARCH FOR NUCLEAR REACTORS. Roy, R. B. (Aktiebolaget Atomenergi, Stockholm). Tek. Tidskr., 18: 433-6(1967). (In Swedish).

Fundamental research on problems specific for nuclear reactor materials is surveyed. Embrittlement mechanisms of pressure vessel steels and nuclear fuel canning materials are summarized and discussed together with stress corrosion from the metallurgical point of view. (SWEDEN)

32884 X-RAY STUDY OF COLD WORK AND RECOVERY IN SOME HCP METALS AND ALLOYS. Lele, Shrikant; Anantharaman, T. R. (Banaras Hindu Univ., India). Z. Metallk., 58: 461-4(July 1967).

The broadening of Debye–Scherrer line profiles obtained from plastically deformed Ti, Zr, and Hf was analyzed by line-breadth as well as Fourier methods. It is found that the broadening on cold work results principally from fragmentation of coherently diffracting domains and straining of the crystal lattice. Incidence of some stacking faults (1 fault in 125 basal planes) during deformation is evident in the case of Ti, but not in the other two metals. Line-breadth analysis of Debye–Scherrer profiles obtained from Ti, Zr, and Hf specimens cold worked and annealed in vacuo at 275, 550, and 800°C for two hours revealed that recovery of the size of the domains is more rapid than the disappearance of lattice strains. Further, the recovery of strain was found to be incomplete even at 800°C. This is interpreted in terms of gas absorption during annealing. (auth)

32885 CALORIMETRIC STUDIES OF δ, δ', AND ϵ PLUTONIUM. Engel, Th. K. (Mound Lab., Miamisburg, Ohio). Contract AT(33-1)-Gen-53. J. Nucl. Mater., 23: 25-9(July 1967). (MLM-1386J).

The heat capacities of the δ, δ', and ϵ phases of Pu were measured in an isothermal calorimeter, the determinations resulting in the mean values of 8.76 ± 0.40, 8.50 ± 0.27, and 8.06 ± 0.39 cal/g-atom·°C, respectively. Latent heat of transition measurements indicated that the $\delta \rightarrow \delta'$ transformation occurred isothermally at 468 ± 2°C in electrorefined Pu, requiring only 7 ± 3 cal/g-atom. By comparison, the latent heat of the $\delta' \rightarrow \epsilon$ transition at 481°C was 460 ± 8 cal/g-atom. (auth)

32886 MIGRATION OF GAS BUBBLES IN IRRADIATED URANIUM DIOXIDE. Gulden, Mary Ellen (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater., 23: 30-6 (July 1967).

Migration of fission gas bubbles in irradiated UO_2 was studied, using electron microscopy, under isothermal annealing conditions at 1400, 1450, and 1500°C. Bubbles with radii greater than 37 Å had a dependence of bubble migration distance on bubble radius that was characteristic of a migration mechanism controlled by volume diffusion. Migration rates were very much smaller than would be predicted from a surface-diffusion-controlled mechanism. The activation energy for bubble migration was found to be 130,000 cal/mole. Smaller bubbles migrated at a slower rate than predicted by a volume-diffusion-controlled mechanism. (auth)

32887 EFFECT OF CARBON ON THE ELECTRICAL RESISTIVITY AND ALLOTROPIC TRANSFORMATION OF THORIUM. Chiotti, P.; Dooley, G. J. (Ames Lab., Iowa). Contract W-7405-eng-82. J. Nucl. Mater., 23: 45-54(July 1967). (IS–1504).

The effects of C on the electrical resistivity, melting temperature, and the alpha-beta transformation of Th were investigated. Particular emphasis was placed on the composition range 0 to 10 at. % (0 to 0.57 wt %) C. High-purity fcc (alpha) Th transforms to bcc (beta) Th at 1350 ± 10°C. C raises the transformation temperature and lowers the melting temperature. An eutectic horizontal at 1720 ± 10°C extends from 4.0 to 8.2 at. % C and forms the upper temperature boundary for the alpha plus beta phase field. The eutectic composition is approximately 5.1 at. % C. The room-temperature electrical resistivity is strongly dependent on the thermal and mechanical history of the specimen. Cold worked and annealed alloys slowly cooled to room temperature gave resistivity values that can be represented by the relation $\rho = 16.09 + 4.223\ X$, where ρ is in $\mu\Omega \cdot$cm and X is the C content from zero to 4.0 at. %. The standard deviation for the intercept at zero C content is ±0.23. The room-temperature resistivity of high-purity C-free Th is 15.9 ± 0.2 $\mu\Omega \cdot$cm. (auth)

32888 GRAIN SIZE–FRACTURE STRESS RELATIONSHIP OF URANIUM. Newman, G. T.; Beevers, C. J. (Univ. of Birmingham, Eng.). J. Nucl. Mater., 23: 95-7(July 1967).

It is shown that if the mode of crack growth is constant over the grain size range examined then a Petch-type relation ($\sigma + \sigma_0 + k_f d^{-\frac{1}{2}}$) can be successfully used to represent the grain-size dependence of fracture stress of uranium. In the relation σ_f is the fracture stress of α-uranium, $d^{-\frac{1}{2}}$ is the reciprocal of the square root of the grain size, and σ_0 and k_f are constants. (M.C.G.)

32889 HYDROGEN EMBRITTLEMENT IN URANIUM. Beevers, C. J.; Newman, G. T. (Univ. of Birmingham, Eng.). J. Nucl. Mater., 23: 10-18(July 1967).

Metallographic and mechanical observations of U and U thermally charged to contain 1.25 to 15 ppM H are reported. The results showed that the formation of uranium hydride precipitates is a primary source of embrittlement in U–H alloys and that maximum embrittlement occurs in alloys containing approximately 2.5 ppM H. The influence of strain rate (2.6×10^{-2}/sec to 1.3×10^{-5}/sec) and grain size (0.0075 to 0.180 mm) on the fracture stress of thermally charged uranium–hydrogen alloys is also reported. In U, cathodically charged to contain uranium hydride precipitates, the embrittlement was shown to be sensitive to the orientation of the precipitates to the tensile axis. (auth)

32890 RESPONSE OF LITHIUM FLUORIDE TO REACTOR NEUTRONS. Simpson, R. E. (Walter Reed Army Inst. of Research, Washington, D. C.). Nucl. Appl., 3: 500-6(Aug. 1967).

A study has been made of the response of normal LiF and that depleted of ^{6}Li when exposed to pure γ rays and to the mixed neutron-plus-γ fields of reactors. Results from a study of the glow curves of the two materials after γ-ray exposure are similar. However, after reactor exposures in a known field of thermal neutrons and γ rays, significant differences were found in the 200 and 275°C glow peaks for approximately the same integrated area under the curves. Presumably these are principally due to differences in the specific ionization of recoil electrons from gamma rays relative to that of the alpha particles and ^{3}H recoils from the ^{6}Li$(n,\alpha)^3$H reaction. By using thermal-neutron shields of ^{6}Li or Cd, the pure γ dose can be obtained from the usual γ ray glow curves from either material. The response (integrated light output) of the depleted LiF per 10^{10} n/cm^2(th) equals that caused by 0.7 rad of ^{60}Co γ rays, while the corresponding response of the normal phosphor exceeds that from 200 rad of γ rays. Having determined the response of these materials to thermal neutrons, and considering the relative independence of the response (per rad) upon γ-ray energy, one may use the depleted phosphor to determine γ-ray dose within a reactor environment and the normal material as an auxiliary thermal-neutron-plus-γ-ray detector. (auth)

32891 STUDY OF THE MECHANICAL AND THERMAL PROPERTIES OF URANIUM ALLOYS WITH SMALL ADDITIONS. Collot, C. (Commissariat a l'Energie Atomique, Paris); Lauque, J.-P.; Colombie, M. Mem. Sci. Rev. Met., 64: 393-402(Apr. 1967). (In French).

The behavior of U alloys containing small quantities of Cr, Si, Mo, and Zr was studied. In connection with different types of observed structure, the mechanical properties of U–Cr–Si–Zr alloys were measured at room temperature. Their evolution as a function of temperature was investigated at 25 to 500°C. Dimensional and structural stabilities of U–Cr–Si–Zr and U–Cr–Mo–Zr were also examined. (tr-auth)

32892 TEMPERATURE EFFECTS ON INTERNAL FRICTION OF MOLYBDENUM WIRE. Belyakov, A. A.; Elyutin, V. P.; Mozzhukhin, E. I. (Moscow Inst. of Steel and Alloys). Fiz. Metal. Metalloved., 23: 306-11(Feb. 1967). (In Russian).

Internal friction in molybdenum wire was investigated. It is shown that impurities added to the molybdenum influence the grain and recrystallization peaks and change the background of the high-temperature internal friction. The activation energy values for the friction of wire with special additions were lower than in wires of pure molybdenum. The latter was related to structural dislocation in the wire. (tr-auth)

32893 INFLUENCES OF THE ADDITIONAL ELEMENTS ON SOME PROPERTIES OF HIGH ZIRCONIUM Cu-Zr ALLOYS. Suzuki, Hisashi; Kawakatsu, Ichiro; Kitano, Hitoshi; Murase, Akeji (Tokyo Univ.). Nippon Kinzoku Gakkaishi, 31: 14-19 (1967). (In Japanese).

The effects of additional elements on the properties of Cu–about 1.3% Zr alloy were studied. Each element such as Be, Ti, Cr, Fe, Ni, Co, misch metal, Al, Si, As, Ag, Cd, Sb, and Te was added at a rate of less than about 0.5% to the straight alloy. Specimens were cast, hot-worked at about 850°C, solution-annealed at 880 to 890°C for 40 min, quenched, and finally cold-rolled by about 83% to become 0.5 mm thickness sheets. Properties of the specimens in various aged states were examined. Hardness increased with increasing additional elements, excepting the addition of misch metal and Sb which caused a decrease in hardness. Tensile strength was generally improved with increasing additional elements, particularly by the addition of Ti, Cr, Co, and a very small amount of Si. Elongation at half-softening-temperature decreased generally with the additions. Electrical conductivity decreased slightly with increasing additional elements except Ti, Fe, and Al. Softening resistance and high temperature hardness were improved by the addition of Cr, Co, Si, and As. Oxidation resistance was also improved by the additional elements except Te. It was found that the alloys of Cu–Zr–Cr, Cu–Zr–Co, and Cu–Zr–Si systems were superior to the others as well as to the binary alloy, as high-strength, conductivity, and heat resistant materials. (auth)

32894 ON THE CREEP-RUPTURE STRENGTH OF MOLYBDENUM COMPOSITE CAST WITH NIMONIC 90 ALLOY. Yoda, Rempei; Arai, Takashi (National Research Inst. for Metals, Tokyo). Nippon Kinzoku Gakkaishi, 31: 90-4(1967). (In Japanese).

In order to increase the oxidation resistance of molybdenum at high temperatures in air, a coating method was developed. Commercially pure molybdenum rods were covered with Nimonic 90 nickel-base alloy which is hot-workable, oxidation-resistant, and forge-worked. The technique was named the composite cast-working method. After the composite cast materials were hot-swaged, they were creep-rupture tested at 1000°C with a stress of 5 to 10 kg/mm² in air. It was possible to work the hard and brittle diffusion zone formed in the interface between molybdenum and the covering alloy without cracking. It was possible to heat and work molybdenum freely in air, and to make the materials stable even if the discontinuities in bonding were formed when molybdenum was composite cast with Nimonic 90 alloy. The creep-rupture strength of the composite cast materials at 1000°C in air was improved to a great extent as the part of the molybdenum core was increased, while the effect on the strength was negligible when the molybdenum core was small. The creep-rupture strength of these materials depended on the area of both molybdenum under the same condition in vacuum. It was indicated that the new coating method using Nimonic 90 alloy can protect molybdenum from oxidation at elevated temperatures in air. (auth)

32895 SPECIFIC HEAT OF LANTHANUM, PRASEODYMIUM, NEODYMIUM, AND SAMARIUM METALS BETWEEN 3 AND 25°K. Lounasmaa, O. V. (Argonne National Lab., Ill.); Sundstroem, Lorna J. Phys. Rev., 158: 591-600(June 15, 1967).

Results of specific-heat measurements are reported for lanthanum, praseodymium, neodymium, and samarium metals in the temperature range between 3 and 25°K. The observed anomalies in the specific heat can generally be related to those found in several other physical properties of the metals. Analysis of the total specific heat C_p into its component parts is based on the assumptions that for each metal the electronic term is $C_E = 10.5T$ mJ/mole °K and that the lattice contribution is the same as for nonmagnetic lanthanum. The magnetic specific heat can thus be determined and is investigated in terms of the magnetic behavior of the various metals. Lanthanum displays anomalies at T_α = 4.88°K and T_β = 5.87°K which are associated with superconducting transitions in the hexagonal and fcc phases of the sample. The Debye Θ below 4°K is 142°K. Praseodymium has a small hump in C_p near 3.2°K, the cause of which is not yet clear. Modifications of existing theoretical models for crystalline-field splitting of the Pr^{3+} ion ground state are suggested. For neodymium the two λ-type peaks at 7.43 and 19.55°K are discussed in relation to Schottky curves for split ground states of ions in hexagonal and cubic sites. The introduction of cooperative effects and exchange interactions would allow the Schottky anomalies to reform into the observed shapes. Samarium shows a small sharp peak in C_p at 9.57°K, the existence of which had not previously been established. This metal also has a large anomaly at 13.3°K associated with antiferromagnetic rearrangement of the ions; the magnetic entropy up to 25°K is very close to the value ½R ln 2. (auth)

32896 ON THE ELASTIC ANISOTROPIES AND ITS TEMPERATURE CHANGE OF SINGLE CRYSTALS OF HIGH ELASTICITY ALLOY "DIA-FLEX" IN THE Co–Fe–Ni–Cr–W–Mo SYSTEM. Masumoto, Hakaru; Saito, Hideo; Kikuchi, Michio (Research Inst. of Electric and Magnetic Alloys, Sendai). Nippon Kinzoku Gakkaishi, 31: 263-8(1967). (In Japanese).

Thermal expansion in the temperature range of 0 to 800°C, Young's modulus in the temperature range of –50 to 300°C, rigidity modulus in the temperature range of 10 to 50°C, and the mechanical strength at room temperature in a high elasticity alloy of fcc type Dia-flex consisting of 38.0% Co, 22.4% Fe, 16.5% Ni, 12.0% Cr, 4.0% W, 4.0% Mo, and small amounts of other elements were measured in single crystals and annealed polycrystals (in the predominant direction ⟨112⟩ (1$\bar{1}$0): Young's modulus 23.00×10^5 kg/cm², elastic limit 120 kg/mm², and tensile strength 250 kg/mm²). The volume compressibility, principal elastic parameters S_{ij}, principal elastic constants C_{ij}, Young's modulus, and the rigidity modulus in three principal orientations of the single crystals were calculated. Young's moduli at 20°C are 11.68×10^5 kg/cm², 22.49×10^5 kg/cm², and 33.78×10^5 kg/cm², and the rigidity moduli at 20°C, 12.01×10^5 kg/cm², 5.93×10^5 kg/cm², and 5.33×10^5 kg/cm², respectively in the orientations of ⟨100⟩, ⟨110⟩, and ⟨111⟩ of the single crystals, showing high anisotropies of elastic moduli. The anisotropy of the temperature coefficients of elastic moduli was also high. (auth)

32897 DISCUSSION: HYDROGEN IN NONFERROUS METALS. Hardie, D. (Newcastle Univ., Eng.); Turner, A. N. J. Inst. Metals, 95: 188-92(June 1967).

The physical chemistry of the interaction of hydrogen is reviewed. Observations and experimental results are reported on the mechanical effects associated with hydrogen, in dissolved and combined form, in Ti, Zr, Ni, Mg, U, Pd, and their alloys. The problems in processing nonferrous metals due to hydrogen, effects associated with porosity and individual contributions related to Cu, Al, and their alloys are reviewed. Discussion ranged over the subjects of terminology, heat of reaction in hydrogen absorption, the effect of hydrogen in Ti, Zr, and Zr–Mo alloys, degassing of Cu alloys, and the mechanical effects of hydrogen-induced porosity in Al alloys. (UK)

32898 THE EFFECT OF THE ADDITION OF TUNGSTEN ON THE PROPERTIES OF NEW MAGNET ALLOY "MALCOLLOY" IN THE SYSTEM OF COBALT AND ALUMINIUM. Masumoto, Hakaru; Kobayashi, Takeo; Watanabe, Kiyoshi. (Research Inst. of Electric and Magnetic Alloys, Sendai). Nippon Kinzoku Gakkaishi, 31: 254-8(1967). (In Japanese).

A new magnet alloy, Malcolloy of high coercivity in the system of cobalt and aluminum was studied. Additions of tungsten increased the coercive force of the binary alloys. The alloy that exhibited the highest coercivity had the composition of 75.89% Co, 13.55% Al, and 10.56% W, and showed the coercive force of 1450 Oe, the residual magnetic flux density of 3100 G and the maximum energy product of 1.40×10^6 G Oe when tempered at 525°C for 150 hours after water quenching from 1380°G. The alloys consisted of many ferromagnetic elongated particles about 350 Å in diameter which were dispersed in the matrix of nearly nonmagnetic β′ phase. It was concluded that the high coercivity of the alloys was mainly caused by the presence of the fine particles of a single magnetic domain. (auth)

32899 INFLUENCE OF THE PRECIPITATES ON THE MECHANICAL PROPERTIES OF Zr–Cu ALLOYS. Armand, M.; Demars, H.; Givord, J. P. Mem. Sci. Rev. Met., 44: 249-60 (Mar. 1967). (In French).

Study of unalloyed Zr, of Zr with 0.5% Cu, with 1.6% Cu and with 2.5% Cu after homogenizing in the β region followed first by rapid cooling then by a stabilization anneal in α phase. The influence of Cu is associated with the structure evolution, especially with the precipitation of the compound determined as Zr_2Cu in the α-Zr matrix. (auth)

Structure and Phase Studies

Refer also to abstracts 32865, 32869, 32876, 32885, 32887, 32891, 32938, and 33539.

32900 (AECL-2668) THE USE OF ELECTRICAL METHODS FOR INVESTIGATING THE GROWTH AND BREAKDOWN OF OXIDE FILMS ON ZIRCONIUM ALLOYS. Cox, B. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan. 1967. 60p. Dep. CFSTI. CAN $2.00.

Methods were developed for characterizing the distribution and dimensions of holes in Zr oxide films large enough to permit molecular flow. The techniques were used to follow the development of cracks and pores in oxide films on Zr alloys during transition processes showing that certain groups of cracks, which appeared at an early stage in the transition process, subsequently disappeared. Breakdown of the oxide film following a reduction in the oxidation temperature; the effect of vacuum annealing on the oxide film; and local variations in the oxide properties were also examined. A rough correlation was observed between the rate of change of capacitance at long immersion times and the post-transition oxidation rate. (auth)

32901 (BM-RI-6956) THE TUNGSTEN–COBALT SYSTEM FOR COMPOSITIONS TO 85 ATOMIC PERCENT COBALT. Neumeier, Leander A.; Holman, J. L. (Bureau of Mines, Rolla, Mo. Rolla Metallurgy Research Center). June 1967. 80p.

A refinement of the W–Co phase diagram is presented for compositions to 85 at. % Co and for temperatures to the solidus. Preparation of alloys by powder metallurgy methods is described, and the results of studies made by a combination of techniques involving microscopy, X-ray diffraction, thermal analysis, and dilatometry are discussed. The existence of μ-W_6Co_7 is confirmed (rhombohedral $D8_5$ structure). The W_6Co_7 phase forms peritectically at 1,685 ± 15°C by reaction of liquid with primary W; the peritectic melt is at 71 at. % Co. The homogeneity range of μ-W_6Co_7 extends to both sides of the ideal stoichiometric ratio, through a compositional range of about 5 at. %. The compositional limits for μ-W_6Co_7 vary slightly below 1,471 ± 5°C, the temperature of the eutectic reaction forming μ-W_6Co_7 plus α. The eutectic composition is at 79 at. % Co. The existence of WCo_3 is confirmed (hexagonal DO_{19} structure). WCo_3 forms peritectoidally at 1,093 ± 5°C by reaction between α and μ-W_6Co_7 and exists over a narrow homogeneity range of 0.5 to 0.6 at. %. The solid solubility of Co in W is low (maximum 0.9 at. % Co) and results in contraction of the W lattice. W is extensively soluble in α–Co at higher temperatures; the α–Co lattice is expanded by the presence of W in solid solution. There was no indication of the formation of a σ-phase nor of any intermediate phases other than W_6Co_7 and WCo_3. The W_6Co_7 and WCo_3 phases are compared with similar phases in other systems. (auth)

32902 (CEA-R-3127) ANALYSE QUANTITATIVE DES TEXTURES DEVELOPPEES DANS UNE PLAQUE DE ZIRCONIUM FILEE A CHAUD. (Quantitative Analysis of Textures Produced in a Hot-Extruded Zirconium Plate). Couterne, Jean-Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1967. 106p. (In French). Dep. Thesis. Submitted to Univ., Paris.

The textures produced in zirconium by extrusion at 730°C of a cylindrical billet in the form of a plate having a rectangular cross section have been studied by the Schulz method using an isotropic standard. These textures have been determined both parallel to the plane of the plate and parallel to the plane of the sides. The results were analyzed, and it was found that particularly near the edges of the plate, certain components of the textures observed in the two series of recordings are in fact aspects of the same texture seen from two different angles. It was also found that the zirconium thus shaped has cold-work textures, and also recrystallization textures formed after the preceding cold-working. If the observed textures are considered schematically, two of these are similar to those found in rolled products: these textures are such that the (0001) planes are inclined at 36° and 60°, respectively, with respect to a plane tangential to the curve (envelope of transverse flow rates) resulting from the extrusion geometry under consideration; the third texture is defined by the fact that the (0001) plane is orthogonal to the exterior surfaces of the plate. The direction of extrusion associated with these planes and common to the three textures is of the type $(10\bar{1}0)$. Dilatometric tests have been carried out on samples taken both parallel and perpendicular to the extrusion direction. These tests show that the zirconium is dilatometrically anisotropic and that a plot of $(\alpha_v)_a$ against temperature shows a change of gradient at 400°C; this latter effect may be due to the change in the electronic configuration of the metal occurring at this temperature. (auth)

32903 (DRI-2397) I. THE DETERMINATION OF THE NIOBIUM-RICH REGION OF THE TERNARY PHASE DIAGRAM, NIOBIUM–ALUMINUM–ZIRCONIUM. II. PHASE EQUILIBRIA OF THE NIOBIUM–TUNGSTEN–HAFNIUM AND NIOBIUM–TUNGSTEN–ZIRCONIUM ALLOY SYSTEMS. III. STUDIES OF THE EFFECT OF INTERSTITIAL ADDITION ON THE PHASE EQUILIBRIA OF THE NIOBIUM-RICH REGION OF THE NIOBIUM–TUNGSTEN–HAFNIUM AND NIOBIUM–TUNGSTEN–ZIRCONIUM ALLOY SYSTEMS. Summary Report. Yamamoto, Albert S. (Denver Research Inst., Colo.). May 1967. Contract AT(11-1)-1092. 92p. Dep. CFSTI.

Phase equilibria studies in the Nb-rich region of the three ternary alloy systems, Nb–Al–Zr, Nb–W–Hf, and Nb–W–Zr, were conducted using metallographic techniques as the primary tool. X-ray diffraction analysis data aided in the microscopic interpretation of the annealed-and-quenched alloy structure and the construction of isothermal sections in each alloy system. Additionally, the effect of small C and/or O additions on the phase equilibria in the Nb-rich region of the Nb–W–Hf and Nb–W–Zr systems was investigated using the same techniques. (auth)

32904 (ORNL-P-3101) FORMATION AND CHARACTERIZATION OF AN A15-TYPE STRUCTURE IN CHEMICAL VAPOR DEPOSITED TUNGSTEN–RHENIUM ALLOYS. Federer, J. I.; Spruiell, J. E. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 25p. (CONF-670905-2). Dep. CFSTI.

For Presentation at Conference on Chemical Vapor Deposition of Refractory Metals, Gatlinburg, Tenn.

An A15-type phase in vapor-deposited W–Re alloys was identified by x-ray diffraction, metallography, and hardness measurements. The composition range of this A15-type phase varied with temperature, but was near W_3Re; at 1000 to 1500°C, the phase occurred alone or coexisted with the tungsten-rich terminal solid solution (β) or with sigma phase (σ). The phase was harder than β, limiting the usefulness of alloys containing the phase as a major constituent. Transformation to β or to $\beta + \sigma$ phases during long-time anneals at deposition temperatures showed that the phase was metastable. Based on a proposed reason for formation during deposition, the phase would not be expected to form in β or $\beta + \sigma$ phase alloys subjected to service at elevated temperatures. (auth)

32905 THE $\beta-\alpha$ PHASE TRANSFORMATION IN HIGH PURITY PLUTONIUM. Rosen, M.; Lloyd, L. T.; Petersen, R. G. (Argonne National Lab., Ill.). pp 18-38 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22-26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The low-temperature phase transformation in high-purity Pu (<200 ppM impurities) was investigated by an ultrasonic pulse technique under both isothermal and quasiequilibrium conditions. The behavior was consistent with a martensitic transition. The time–temperature–transformation diagram displayed two distinct branches. The high-temperature region, above 313°K, exhibited athermal characteristics, which extrapolated to zero isothermal transformation at 367°K. The low-temperature portion was isothermal. Structural damage during transformation, was small in the low-temperature branch, but extensive in the high-temperature range, the formation of voids starting with the beginning of of the phase change. Under quasiequilibrium conditions a hysteresis gap 33°K was observed between the temperature of the transformation on heating and cooling, even at very low rates. The hysteresis is inherent in this $\alpha \rightleftharpoons$ [illegible] transformation, related to its displacive character. Cycling through the transformation caused also fragmentation of the grains. The blocking of dislocations caused them to be partially immobilized, strongly affecting the kinetics of subsequent transformation. During heating semicycles, the sound velocity and ultrasonic attenuation showed discontinuities at 348°K. The attenuation peak and the dip in Poisson's ratio in this temperature region indicated a relaxation of stresses, possibly due to a recovery process. (auth)

32906 THE $\beta-\alpha$ TRANSFORMATION IN SMALL SPECIMENS OF PLUTONIUM METAL. Ekbom, L.; Bogegard, S. (Research Inst. of National Defence, Stockholm). pp 49-53 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22-26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The transformation from β to α phase in Pu was studied. Dilatometric measurements were made on samples with volumes from 0.05 to 25 mm^3 over the temperature range from 57 to 82°C. The transformation rate increased when the sample volume was decreased. The smaller samples also showed a great variation in incubation time. It is suggested that in small samples one nucleus is formed initially. When it grows, new nuclei are formed in a chain reaction leading to rapid transformation. For larger samples internal stresses retard the transformation. (auth)

32907 TRANSFORMATION KINETICS OF THE $\alpha-\beta$ AND $\delta-\alpha$ TRANSITIONS IN PURE AND ALLOYED PLUTONIUM. Faiers, M. E.; Loasby, R. G.; Ward, B. J.; Orme, J. T.; Spicer, B. R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 64-87 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22-26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Measurements of the $\alpha-\beta$ transformation kinetics in pure Pu

and of the $\delta-\alpha$-phase kinetics in a range of Pu–Ga alloys are described. The $\alpha-\beta$ phase change was examined by resistance measurements, under nonisothermal conditions, using heating rates of up to 10^7°C/sec. The results indicate that the incubation periods decrease as the transformation temperature increases from approximately 100 msec at 124°C to 8 μsec at 230°C. Decalescence was observed in the majority of the transitions. Alloys in the range Pu–0.85 at. % Ga to Pu–2.3 at. % Ga, which can be retained as δ-phase at ambient temperature, are shown to be unstable on cooling below ambient, undergoing a time dependent $\delta-\alpha$ transformation. Dilatometry and density determinations were used to study the transformation kinetics, which were found to be both temperature and composition dependent. Results for the effects of cold work and of thermal cycling over the range –80 to 100°C are presented for certain of the alloys. (auth)

32908 STUDY OF ALLOTROPIC TRANSFORMATION OF PLUTONIUM. Spriet, B. (CEN, Fontenay-aux-Roses, France). pp 88-117 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

All allotropic transformations of Pu were studied by dilatometry, thermal analysis, resistivity, and hot stage microscopy. Experiments were performed on standard purity Pu, on zone-melted or solid-state electrolyzed Pu, and on β- and δ-stabilized alloys. The transition temperature and the $\alpha \rightleftharpoons \beta$ stress were shown to affect both transformation kinetics. The mechanism of the two reverse transformations and some features of several other transformations are also discussed. (auth)

32909 COMPOSITIONAL AND PRESSURE EFFECTS IN THE PLUTONIUM–GALLIUM SYSTEM. Gardner, H. R. (Pacific-Northwest, Richland, Wash.). pp 118-32 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Lattice parameters, density, and hardness were determined on Pu–Ga alloys containing 0.37 to 1.26 wt % Ga. Lattice parameters and density decreased with increasing Ga content while hardness increases because of solid-solution strengthening. The effect of a 150,000 lb/in.^{2} pressure on α-phase formation in both cored and homogenized alloy is presented. In addition the stability of $\alpha-\delta$ phase mixtures with respect to annealing and room-temperature storage is discussed. An explanation of the observed behavior of $\alpha-\delta$ phase mixtures is presented. (auth)

32910 THE INFLUENCE OF PRESSURE ON THE STABILIZATION OF THE δ PHASE OF PLUTONIUM BY GALLIUM. Roux, C.; Le Roux, P.; Rapin, M. (CEA, Paris). pp 133-6 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22-26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Experiments are described, which show that δ-stabilized alloys transform when subjected to a hydrostatic pressure. The pressure required to initiate transformation increased with increasing concentration of the alloying element. The results are briefly discussed with respect to existing phase diagrams. (auth)

32911 THE PRESSURE/TEMPERATURE BEHAVIOUR OF PURE PLUTONIUM. Brodsky, M. B. (Argonne National Lab., Ill.). pp 137-9 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Preliminary studies of the pressure–temperature behavior of unalloyed Pu are described. They indicate that the possibility of growing large grains of $\alpha-$Pu is not very high. (auth)

32912 HALL EFFECT AND ELECTRONIC STRUCTURE OF VARIOUS ACTINIDE METALS. Brodsky, M. B. (Argonne National Lab., Ill.). pp 286-98 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The Hall effect was measured for δ Pu alloys that were stabilized with additions of Ce or Al. The Hall coefficient was found to be nearly temperature independent near room temperature but very dependent on temperature at lower temperatures. Behavior of the Hall coefficient at low temperatures is indicative of magnetic ordering: the size of the magnetic effect and the ordering temperature decrease with increasing alloy content. Near room temperature, the values also decrease with increase of alloying element and change from positive values for low Ce content to negative values above 10.4 at. % Ce. The sign of the Hall coefficient remains positive for Al alloys. The higher temperature data were treated by a two-band model for the electronic structure and found to be consistent with a 5f 7s configuration, as was found earlier for α, β, and δ Pu. Hall effect measurements were also made on α neptunium. Calculations, based on a two-band model for these results and for data on Th and U also give results consistent with the 5f 7s configuration. (auth)

32913 DETERMINATION OF ELECTRON BINDING ENERGIES IN PLUTONIUM WITH PHOTO-ELECTRON SPECTROSCOPY. Holm, L. W. (Research Inst. of National Defence, Stockholm) Fahlman, A.; Hamrin, K.; Nordberg, R.; Nordling, C.; Siegbahn, K. pp 299-305 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The electron binding energies in the M_{IV}, M_V, N_{IV}, and N_V subshells of Pu as determined by the electron spectroscopic method are given. The measurements were performed on an oxide sample. (auth)

32914 STUDIES OF THE BINARY SYSTEMS PLUTONIUM–GOLD PLUTONIUM–GALLIUM AND PLUTONIUM–INDIUM. Hocheid, B.; Tanon, A.; Bedere, S.; Despres, J.; Hay, S.; Miard, F. (CEA, Paris). pp 321-40 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The binary phase diagrams Pu–Au, Pu–Ga, and the 0 to 25 at. % In part of the Pu–In diagram were studied using thermal analysis, dilatometry, metallography, x-ray crystallography, and electron beam microanalysis. The Pu–Au alloy contains 8 intermetallic compounds, the compositions of which are approximately 35, 50, 58, 66, 70, 77, 81, and 85 at. % Au and 4 eutectics, the compositions of which are approximately 52, 65, 73, and 90 at. % Au. The Pu–Ga diagram agrees well with that published by LASL. However, additional information was obtained about the composition limits of the high-temperature η phase field, and the features of the 75 to 100 at. % Ga part of the diagram. (auth)

32915 PHASE EQUILIBRIA STUDIES ON THE ALUMINIUM–PLUTONIUM SYSTEM. Runnalls, O. J. C. (Chalk River Nuclear Labs., Ont.). pp 341-57 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

A summary is presented of the solid-state transformations observed recently in the intermetallic phases $PuAl_4$ and $PuAl_3$. Both phases are believed to be Pu-deficient with little or no derivation from fixed compositions. The crystal structures of the α and β forms of $PuAl_4$ appear identical except for the distribution of vacancies in each. After examining a single-phase sample by x-ray powder diffraction techniques, the parameters for the previously published structure of orthorhombic $PuAl_4$ have been modified somewhat. Electron probe and density measurements on three of the four polymorphs of $PuAl_2$ that have been identified ($9H_\alpha$, $9H_\beta$, 6H, and 3H) indicate that their compositions are identical and vacancies may be playing an important role. For cubic $PuAl_2$ an observed variation in lattice parameter within the range $a = 7.833 \pm 0.005$ Å composition change. The perovskite-type compound $PuAlO_3$ was prepared inadvertently while heating Al–Pu intermetallics and was examined by powder diffraction methods. As a consequence it is proposed that $PuAlO_3$ is not rhombohedral a as reported earlier but is isostructural with orthorhombic $BaTiO_3$. (auth)

32916 DIFFUSION OF PLUTONIUM IN THE SOLID STATE. Calais, D.; Dupuy, M.; Mouchnino, M.; Portnoff, A. Y.; Van Craeynest, A. (CEN, Fontenay-aux-Roses, France). pp 358-91 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The methods used to study the solid-state diffusion of Pu are described, including α-counting (Gruzin), autoradiography (Hall), electron microprobe analysis (Matano), and metallography (Jost). Chemical diffusion coefficients are given and also results on the phase diagrams for the systems Mg–Pu, Zr–Pu, U–Pu, Al–Pu, and Th–Pu. (auth)

32917 PHASE EQUILIBRIA IN THE TERNARY SYSTEM PLUTONIUM–CERIUM–IRON. Tucker, Philip A.; Etter, Don E.;

Gebhart, James M. (Monsanto Research Corp., Miamisburg, Ohio). pp 392-404 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The equilibrium phase diagram of the Pu–Ce–Fe system is presented, based on data obtained by differential thermal analysis, metallography, x-ray diffraction, and electron microprobe x-ray analysis. Liquid-solid phase transitions were found between 411 and 1540°C. Six crystalline phases solidify as primary phases from molten Pu–Ce–Fe solutions. No ternary compounds occur in the system, and there are no ternary eutectics. A continuous series of solid solutions is formed by the binary compounds $CeFe_2$ and $PuFe_2$. The primary phase field for this solid solution covers a major portion of the phase diagram. A slightly inclined eutectic valley with steep sides extends across the diagram at approximately 13 at. % Fe with temperatures ranging from 411 to 660°C. There are four ternary invariant points on the liquidus surface, three peritectics, and one saddle point. (auth)

32918 PHASE DIAGRAMS OF PLUTONIUM WITH THE METALS OF GROUPS IIA, IVA, VIIIA, AND IB. Kutaitsev, V. I.; Chebotarev, N. T.; Lebedev, I. G.; Andrianov, M. A.; Konev, V. N.; Menshikova, T. S. (Academy of Sciences, Moscow). pp 420-49 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

A large number of alloy systems were studied using differential thermal analysis, dilatometry, metallography, and x-ray diffraction. Much of the work was done on samples weighing between 10 and 300 mg. In certain cases electrical resistivity and magnetic measurements were made while high pressures were sometimes employed to establish equilibrium conditions. The alloy systems studied were the binaries with Sc, Y, Pr, Nd, Gd, Tl, Zr, Hf, Ru, Rh, Pd, Ir, Pt, Cu, Ag, Au, and the ternary Pu–Ce–Ni. The observations are compared with existing phase diagrams. (auth)

32919 PLUTONIUM–GOLD SYSTEM. Selle, James E. (Monsanto Research Corp., Miamisburg, Ohio). pp 450 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Differential thermal analysis, metallography, and electron microprobe analysis were used to make a preliminary survey of the system. In the region investigated, 5 intermetallic compounds and 2 eutectics were found. Electron microprobe data indicate that the most probable compositions of these compounds are: AuPu (50.0 at. % Au), Au_5Pu_4 (55.6 at. % Au), Au_3Pu (75.0 at. % Au), Au_4Pu (80.0 at. % Au), and Au_5Pu (83.3 at. % Au). A eutectic exists between Au_5Pu and Au at about 89 at. % Au at a temperature of 780 ± 3°C. No data are available on the composition of the second eutectic. The compounds Au_4Pu and Au_5Pu were found to melt incongruently at 855 ± 5 and 795 ± 5°C, respectively. The melting points of the remaining compounds were greater than 1000°C. (B.L.M.)

32920 PHASE STUDIES IN THE SYSTEM: ZrO_2–TiO_2. Deshpande, V. V.; Rama Rao, K. (Coll. of Science, Nagpur, India). Curr. Sci. (India), 36: 374(July 20, 1967).

Results are reported on detailed studies of ZrO_2–TiO_2 system. Equimolar proportions of zirconia and titania were mixed together and fired at 1400°C for 20 hr. The product was cooled, powdered, and examined by x-ray techniques. A Guinier photograph showed two phases, monoclinic zirconia solid solution and $ZrTiO_4$. The product was refired at 1660°C for 10 hr in air and analyzed again. Only one phase, $ZrTiO_4$, was found. It was indexed on the bases of orthorhombic unit cell with the following lattice constants: a = 4.800, b = 5.008, and c = 5.451 Å. There was no evidence of any other compound in the system. (P.C.S.)

32921 DISCUSSION OF "TRANSMISSION ELECTRON MICROSCOPY OF Pu-1 WT. PERCENT Ga" BY A. W. BREWER AND F. J. FRAIKOR. Douglass, D. L.; Bronisz, S. E. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 23: 107-8 (July 1967).

Specimens were thinned electrolytically in a standard solution for electropolishing Pu and U. The alloys examined contained 8 at. % Al or 1.7, 3.3, or 5.0 at. % Ga. Calculations based on measurements of the two sets of spots in the diffraction pattern indicated that the inner set came from PuO_2. While the outer set was caused by delta-Pu. When the thin foils were heated the final product was PuO_2. (M.C.G.)

32922 THE PHASE AB_2 IN THE TERNARY SYSTEMS La–Sb–Te AND La–Sn–Sb. Wang, R.; Steinfink, H.; Raman, A. (Univ. of Texas, Austin). Inorg. Chem., 6: 1298-1300(July 1967).

Ternary alloys of the sections $LaSb_2$–$LaTe_2$ and $LaSn_2$–$LaSb_2$ were investigated by x-ray diffraction techniques. The substitution of Te by Sb in the first system produced an orthorhombic distortion of the tetragonal $LaTe_2$ structure. The maximum solubility of Sb in $LaTe_2$ led to the terminal composition $LaSb_{1.5}Te_{0.5}$. In the $LaSn_2$–$LaSb_2$ section no alloy of the type $LaSn_{2-x}Sb_x$ for $0 \leq x < 2$ existed. A phase $LaSnSb_2$ was found, and it was isostructural with $NdTe_3$. (auth)

32923 INFLUENCE OF THE SOLUBILITY LIMIT OF CHROMIUM IN β-URANIUM ON THE ISOTHERMAL TRANSFORMATIONS OF URANIUM–CHROMIUM ALLOYS TEMPERED FROM 720°C. Violle, Michel; Degois, Michel (CEA, Gif-sur-Yvette, France). Compt. Rend., Ser. C, 264: 1629-32(May 17, 1967). (In French).

The U–Cr alloy containing 1 at. % Cr is intermediate between the alloys homogeneous at 720°C in the β phase, which are the seat, between 400 and 600°C, of a perlitic transformation and, below 400°C, of an apparently bainitic transformation and alloys not homogenizable with β alloys, which undergo only the perlitic transformation. (tr-auth)

32924 ELASTIC CONSTANTS OF THE INTERMEDIATE PHASE UCo_2. Gibson, E. D. (Ames Lab., Iowa). J. Appl. Phys., 38: 3026(June 1967). (IS-1537).

Elastic constants were measured for the intermediate phase of UCo_2 at 77 to 300°K. From the 0°K elastic constants and a computer program based on De Launay's Case II method, the Debye temperature Θ_D of UCo_2 was calculated to be 286°K. (M.O.W.)

32925 THE PHASE EQUILIBRIA IN THE TERNARY SYSTEMS ZIRCONIUM–VANADIUM–BORON, ZIRCONIUM–NIOBIUM–BORON, AND ZIRCONIUM–MANGANESE–BORON. Voroshilov, Yu. V.; Kuz'ma, Yu. B. Porosh. Met., Akad. Nauk Ukr. SSR, No. 6, 49-52(June 1967). (In Russian).

The Zr–V–B, Zr–Nb–B, and Zr–Mn–B were investigated by means of x ray techniques and the phase equilibria were established at 900 (Zr–V–B, Zr–Mn–B) and 1500°C (Zr–Nb–B). The compounds with the η-phase structure were found in systems Zr–V and Zr–Mn in little quantity of the O_2 or N_2 (a = 12.153 and 11.999 Å, respectively). Solid solutions of Zr in NbB and Nb_3B_2 were established. The compound NbB dissolved 30 at. % Zr and its lattice constants grew: a = 3.298–3.325 Å, b = 8.722–8.813 Å, c = 3.164–3.175 Å. The compound Nb_3B_2 dissolved 6 at. % of Zr and its lattice constants grew: a = 6.185–6.202 Å, c = 3.281–3.295 Å. (auth)

32926 PROOF OF DISLOCATIONS IN TUNGSTEN AND MOLYBDENUM BY ELECTROLYTIC ETCHING. Pink, Erwin (Metallwerk Plansee AG, Reutte/Tirol, Austria). Jena Rev., No. 1, 36-39(1967).

Equipment is described with which the polishing and etching process can be observed using a microscope that magnifies the image 200 times. The method of operation for the equipment is described and results of the process are discussed. (J.R.D.)

32927 STRUCTURAL STUDY OF NIOBIUM–IRON ALLOYS. Raman, A. (Univ. of Texas, Austin). Proc. Indian Acad. Sci., Sect. A, 65: 256-64(Apr. 1967).

The niobium–iron system was reinvestigated and a possible revised phase diagram is presented incorporating pertinent results of previous investigators. $Nb_{48}Fe_{52}$ ($Nb_{19}Fe_{20}$) was found to crystallize in the μ-phase structure (W_6Fe_7-type). A Ti_2Ni-type phase or a σ phase, reported in the literature, was not found to exist in the system. Small amounts of carbon, aluminum, or silicon did not stabilize these phases. The Laves phase $NbFe_2$ has a wide homogeneity range from 64 to 72 at. % Fe. The possibility of considering the Laves phases as electron compounds closely related to the σ family is discussed. (auth)

32928 INTERDIFFUSION IN THE SYSTEM Zr–15 AT. PERCENT U. Pavlinov, L. V. At. Energ. (USSR), 22: 290-2(Apr. 1967). (In Russian).

The interdiffusion in the system Zr–15 at. % was investigated; the diffusion coefficients in the high temperature body centered phase were determined at 950 to 1450°C with use of α-irradiated U. It was shown that the alloying of Zr with U leads to a decrease of the diffusion mobility throughout the temperature interval studied and increase of the activation energy. The temperature dependent of the diffusion coefficients of U and Zr obtained by extrapolation of the diffusion parameters to 0 concentration of U is represented by the equation $D = 1.40 \times 10^{-4} \exp(-27{,}700/RT)$ cm²/sec. (tr-auth)

Radiation Effects

32929 (AECL–2684) IRRADIATION OF U_3Si. INTERIM RESULTS AFTER 7360 MWd/tonne U. Feraday, M. A.; Chalder,

G. H.; Cotnam, K. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr. 1967. 34p. (EXP-NRX-52208). Dep. CFSTI. CAN $1.00.

Enriched U–Si alloy specimens close to the U_3Si composition (U-3.9 wt % Si) and clad in Zircaloy-2 are being irradiated in the X-5 pressurized-water loop at powers of 600 to 800 W/cm length. Extrapolation of the swelling curve indicated a total volume increase in U_3Si of 13% after a burnup of 10,000 MWd/tonne U. Destructive examination of selected specimens showed that the U_3Si was plastic enough to flow into a 7 vol % central void provided in the fuel, suggesting that the total volume increase could be accommodated without excessive sheath strain. (auth)

32930 (BNWL–211) METALLOGRAPHIC EVIDENCE OF STRAIN- AND IRRADIATION-INDUCED PRECIPITATION IN PRECONDITIONED HASTELLOY X-280. Levy, I. S.; Wheeler, K. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1966. Contract AT(45-1)-1830. 13p. Dep. CFSTI.

Tensile specimens of Hastelloy, X-280, a solution-hardenable Ni-base alloy, were given various preirradiation thermomechanical treatments. They were subsequently irradiated at 540°F to approximately 1×10^{20} nvt, tensile tested at 1350°F, and subjected to metallographic examination. Comparisons were made with metallographic examinations performed on control specimens given similar treatments. Evidence is presented of the occurrence of precipitation induced by strain, by irradiation, and by the combination of both strain and irradiation. Tentative identification of the phases produced is made. (auth)

32931 (BNWL–CC–883) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, August–October 1966. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 15, 1966. Contract AT(45-1)-1830. 173p. Dep. CFSTI.

Developments are reported for studies on: tube burst tests on irradiated EBR-II fuel jackets; radiation effects on mechanical properties of type 347 stainless steel; neutron radiation effects on iron; effects of substructure on irradiation stability of ASTM A302 Grade B steel; fracture toughness of reactor pressure vessel steels; radiation effects on notch ductility of steels; radiation effects on refractory metals and heat resistant alloys; effects of helium on mechanical properties of type 304 stainless steel; radiation effects on reactor metals; ATR gas loops; and in-reactor fatigue testing of reactor structural steels. (P.C.H.)

32932 (EURAEC–1817) RESEARCH TO DETERMINE THE LONG-TERM MECHANICAL PROPERTIES OF METALS SUBJECTED TO MECHANICAL STRESS AT ELEVATED TEMPERATURES AND NEUTRON IRRADIATION. Quarterly Report No. 16, October 1–December 31, 1966. Siegfried, W. (Battelle Memorial Inst., Geneva (Switzerland)). Mar. 1967. Contracts 100-62-12 RDS; 057-64-7 TEES (RD). 29p. (EUR–3353). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Results of time-to-rupture tests with and without neutron irradiation were evaluated after comprehensive description of the methods of evaluation applied and discussion of possible errors caused by simplifications. The effects of neutron irradiation on the calculated number of crack initiators were calculated for the following alloys: Hastelloy N; XH77TYuR (Ni-base of Russian origin); and IKI8N9T (Fe-base of Russian origin). In time-to-rupture tests on the alloy Hastelloy N, no increase in crack initiators as a result of neutron irradiation took place either at 650 or 860°C. A strong increase in crack initiators was found in a Russian alloy containing about 0.01% B. This agrees with the metallographic investigations. The Russian alloy without B showed no essential increase in crack initiators as a result of neutron irradiation. (auth)

32933 (GEAP–4812) RADIATION DAMAGE STUDIES OF HIGH-NICKEL ALLOYS. Busboom, H. J.; Comprelli, F. A.; Francke, K. P.; Spalaris, C. N. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Apr. 1967. Contract AT(04-3)-189. 37p. Dep. CFSTI.

Post-irradiation tensile tests at 78 (25); 1100 (593); and 1300°F (704°C) were used to determine the extent of neutron radiation damage to Incoloy-800, -801, -825, Inconel-625, and Hastelloy-X after 1300°F neutron exposures of 3.5×10^{20} n/cm^2 and 2.0×10^{21} n/cm^2, > 1 MeV. The results were compared with those obtained for unirradiated specimens with identical thermal histories. For Incoloy-800, only the elevated temperature ductility was affected significantly by neutron exposure. The other alloys exhibited a strong neutron exposure dependence for both strength and ductility. These metallurgically unstable alloys suffered a more substantial loss in ductility than Incoloy-800. (auth)

32934 (ORNL-P-2922) DOSE RATE, ANNEALING, AND STRESS–RELAXATION STUDIES OF RADIATION HARDENING IN IRON. Paper No. 50. Hinkle, N. E.; Ohr, S. M.; Wechsler, M. S. (Oak Ridge National Lab., Tenn.). Feb. 1967. Contract W-7405-eng-26. 36p. (CONF-660607-6). Dep. CFSTI.

From 3rd International Symposium on the Effects of Irradiation on Structural Metals, Atlantic City.

Effects of dose rate on the increase in yield-stress of a vacuum-melted iron were studied by irradiating tensile samples at dose rates from 2×10^{11} to 3×10^{13} neutrons/cm^2 sec (E > 1 MeV) at 95°C in the poolside of the Oak Ridge Research Reactor. For a dose of 4.6×10^{18} neutrons/cm^2 (E > 1 MeV), a three-fold increase in yield stress occurred, but there was no variation with dose rate in the range investigated. The possible significance of the absence of a dose rate effect is discussed in general terms. Annealing of the radiation hardening took place at 300 to 400°C with an activation energy of about 3 eV. This range of temperatures coincides with that observed for the dissociation of N from radiation-produced traps after electron irradiation. Several models for the annealing process are considered. Stress relaxation measurements on unirradiated and irradiated Fe and Fe–Si are described. Evidence for the existence of an internal or threshold stress, which must be exceeded for macroscopic dislocation motion, is cited. It is pointed out that the major cause of radiation hardening is the increase in this stress. When account is taken of the increase in internal stress on irradiation, the stress relaxation experiments indicate no change in the activation volume for plastic deformation. (auth)

32935 (ORO–2891-6) THE EFFECTS OF NEUTRON IRRADIATION ON THE RESISTIVITY OF BINARY ALLOYS. Progress Report. Lewis, A. B. (Mississippi Univ., University. Dept. of Physics and Astronomy). June 12, 1967. Contract AT(40-1)-2891. 12p. Dep. CFSTI.

Developments are reported for studies on: neutron radiation effects on resistivity of Al–Cu alloys; radiation effects on thermoelectric properties of alloys; fabrication of porous metallic targets; and measurement of neutron flux and energy spectrum. Accelerator operation is also described. The neutron irradiated Al–Cu alloys showed an essentially uniform and small decrease in resistance. Due to the difficulties of cutting Be sheet to the required shape, it was decided to buy prefabricated Be parts for the preparation of Be-faced porous targets. (P.C.H.)

32936 (SC–T–67-0934) INFLUENCE OF RADIOACTIVE RADIATIONS ON THE MECHANICAL PROPERTIES OF SOLID BODIES. Lensky, V. S. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Inzh. Sb., 28: 97-133(1960). 51p. Dep. CFSTI. JCL $5.60 fs, $1.73 mf.

The physical mechanisms of irradiation effects on solid bodies are described. Changes in parameters of lattices, volumes, and densities due to radioactive radiation are discussed. Influence on the plastic, strength, and creep properties is summarized and the effects of radiation on plastics and high polymers are included. A bibliography of 274 references is given. (J.C.W.)

32937 SELF IRRADIATION DAMAGE IN TRANSURANIC ELEMENTS AND COMPOUNDS. Mendelssohn, K. (Oxford Univ.); King, E.; Lee, J. A.; Rand, M. H.; Griffin, C. S.; Street, R. S. pp 189-204 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Self-irradiation effects in transuranic elements and their compounds are compared. Resistivity measurements at low temperatures on metastable β-phase Pu are presented in detail and the relation between the observed saturation effects, and the anomalous resistivities of the Pu phases are discussed. Self-damage effects on the lattice parameters of refractory compounds of Pu and Am at room temperature are discussed in terms of Frenkel defects. (auth)

32938 FURTHER WORK ON ANL ON FAST REACTOR FUELS. Kelman, L. R. (Argonne National Lab., Ill.). pp 525-6 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Irradiation results are reported for fast reactor fuels composed of U–15% Pu–10% Ti and 18.5% Pu–14% Zr clad in V or Ti. Burnups of ~4% at temperatures of 600 to 800°C are reported. Equilibrium phase relations are reported for the system Fe–U–Zr for alloys of >60 wt % U and 0 to 30 wt % Zr. Isothermally annealed and and water-quenched alloys were studied by optical and x-ray metallography. A number of solid phases are reported. (B.L.M.)

32939 ANNEALING OF SELF-IRRADIATION INDUCED DEFECTS IN ALPHA PLUTONIUM STORED AT 87°K. Miner,

W. N.; Elliott, R. O. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Nucl. Mater., 23: 115-17(July 1967). (LA-DC-8684).

The accumulation of self-irradiation-induced defects in an α-Pu specimen stored at 87°K and the annealing of those defects in the range from 5 to 325°K are reported. The resistivity increase observed at 87°K during the accumulation of damage was linear with time but small, amounting to only 0.45 μΩ · cm. This same condition of damage, when measured at 5°K, amounted to an increase of 27 μΩ · cm. The nature of the alpha-particle damage in the metal lattice was assumed to be the creation of interstitial-vacancy pairs. (M.C.G.)

32940 RADIATION DAMAGE AT HIGH TEMPERATURES. Weir, J. R. Jr. (Oak Ridge National Lab., Tenn.). Science, 156: 1689-95(June 30, 1967).

Radioinduced embrittlement at high temperatures was studied in relation to the mechanism that proposes that He bubbles produced in the grain boundaries of irradiated materials cause the problem. Minor modification of the normal working and annealing processes effected some improvement in stainless steel type 304, but development of new alloys seems to be the long-term answer. Three approaches to the problem are discussed: (1) reduction of amount of He generated by reducing the B content in some materials used predominantly in a thermal-neutron flux, (2) reduction of grain size and introduction of hard-precipitate particles in the boundaries, and (3) introduction of precipitate particles into the grains of the alloy. (P.C.S.)

32941 EFFECT OF CONCENTRATION UPON HELIUM PRECIPITATION IN IRRADIATED COPPER–BORON ALLOYS. Hastings, I. J.; Russell, B. (Univ. of Queensland, Brisbane). J. Nucl. Mater., 23: 1-9(July 1967).

The lattice parameter of Cu is proportional to the concentration of dissolved interstitial He up to approximately 0.03 at. %. When the concentration of He is increased to 0.08 to 0.1 at. %, the gas precipitates to form bubbles during irradiation at temperatures in the range from 75 to 100°C. During annealing at 500°C, the lattice parameter contracts owing to the formation of He-vacancy complexes, at a rate that is proportional to the concentration of He. Subsequent expansion of the lattice, caused by the precipitation of these complexes to form bubbles, also occurs at a rate proportional to He concentration. The total time required for gas precipitation is inversely proportional to the He content and this behavior is associated with an increasingly fine scale of gas bubble nucleation. The average size and spacing of bubbles formed during the complete precipitation of He increase with decreasing gas concentration. The bubble density is related to the number of dislocations generated by annealing of displacement defects caused by fast neutron and alpha collisions. However, some homogeneous nucleation may also occur in materials with a high gas concentration. As the gas concentration of He increases, a rapid initial contraction of the lattice develops during the first two min of annealing at 500°C. It is suspected that many of the He atoms formed during irradiation are closely associated with potential vacancy sources such as jogs on dislocations, or clusters of vacancies caused by displacement collisions. At temperatures above those at which the vacancies become mobile, a proportion of these He atoms enter substitutional solution very rapidly because the diffusion distances are short. (auth)

32942 ELECTRON-BOMBARDMENT DESORPTION OF CARBON MONOXIDE ADSORBED ON TUNGSTEN. Sandstrom, D. R.; Leck, J. H.; Donaldson, E. E. (Washington State Univ., Pullman). J. Appl. Phys., 38: 2851-2(June 1967). (RLO-1548-06).

The ion current produced by electron bombardment of the (211) crystal face of a W ribbon is shown to be predominantly O_{16}^{+}. The only impurity detected, H^{+}, was never more than 4% of the total current even when the ribbon operated in H_2 with a CO impurity as low as 1%. (auth)

32943 INVESTIGATION OF 35 MeV ELECTRON RADIATION INFLUENCE UPON PHYSICAL PROPERTIES OF GERMANIUM. Vaikhbrot, E. I.; Val'ter, A. K.; Grizhko, V. M.; Grishaev, I. A.; Nosov, V. M. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 12: 766-72(May 1967). (In Russian).

Measurements of the resistivity, the Hall effect, and the minority carrier life time of the thread-type samples of Ge while being irradiated by 35-MeV linear accelerator electrons are presented. Only taking into account the presence of the light holes, complete agreement between the Hall effect results and resistivity was obtained. In an integrated flux range up to 320 μCi/cm² the ratio values of mobilities b and the absolute value of mobilities are constant. From the extremal value dependences R_H the value of the intrinsic concentration of the carriers n_i was derived. It is (2.2 to 2.4 × 10^{13} cm^{-3}) at 296°K for the sample. (auth)

32944 UTILIZATION OF RESPONSE FUNCTIONS AND DOSE FUNCTIONS FOR RELATING THE DAMAGE PRODUCED IN SOLIDS TO THE NEUTRON FLUX. APPLICATIONS AND EXPERIMENTAL CONFIRMATIONS. Dulieu, P.; Rastoin, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France). Nucl. Eng. Design, 5: 277-84(May 1967). (In French).

Starting from the analysis of the effects produced by a neutron-atom collision, a relation is established between the neutron flux, the neutron spectrum, and the damage caused by the disorder produced in the atomic lattice. Experimental verification for this relation is given by the work of Amayev et al. about steel, by the electrical resistivity measurements in graphite by Kinchin, and by the authors' own experiments with Si p-i-n junctions. (auth)

32945 EFFECTS OF VARIOUS DOPING TREATMENTS UPON THE DAMAGE PRODUCTION AND RECOVERY OF DEUTERON-IRRADIATED ALUMINUM. Herschbach, K. (Douglas Aircraft Co., Inc., Santa Monica, Calif.); Jackson, J. J. Phys. Rev., 158: 661-70(June 15, 1967).

The effects of various doping treatments (cold work, alloying, and/or radiation doping) upon the damage production and recovery of Al irradiated with 20-MeV deuterons have been investigated. Four of a total of six specimens (two made from Al–0.03 at. % Zn alloy, one annealed, and one cold-worked) were irradiated with 10-MeV protons to a total dose of 3.3 × 10^{16} p/cm² at a temperature of about 90°K and annealed for 10 min at 180°K. These four radiation-doped and two additional specimens (one annealed and one cold-worked) were then irradiated simultaneously at a temperature not exceeding 8°K with 20-MeV deuterons to a total integrated dose of 4.85 × 10^{15} d/cm². Isochronal annealing measurements were carried out in situ up to 265°K. Within our accuracy (±10%), the damage production in all six specimens was the same; however, previous experiments indicate a small increase in damage production for doped specimens. No radiation annealing was found in the annealed 99.9999% Al, while a large effect was found in the cold-worked 99.999% Al. Radiation doping produces the radiation-annealing effect in an annealed sample as well as in the alloy, and reduces the effect of cold working. Cold work and alloying reduce the recovery in stage I; radiation doping increases it. The annealing curves for alloys are smoothed out in stage II. Cold work and/or radiation doping do not affect stage II significantly, and all remaining damage anneals out in stage III. Because all six specimens underwent exactly the same thermal history, the difference in annealing, i.e., the percentage of damage left in specimen A minus the percentage of damage left in specimen B, was calculated for different specimen combinations and plotted. These curves reveal many small details in the different annealing behavior which have not been observed previously and which are caused by the different treatments prior to the irradiation. They are discussed in terms of interstitial migration in stage I. Specifically, it is claimed that the crowdion migrates at a temperature of about 45°K and that stage III is composed of (at least) three different annealing processes. (auth)

32946 INTERNAL FRICTION STUDIES OF ELECTRON IRRADIATED GOLD. Jordon, M. R. Reading, Eng., Univ. of Reading, 1967. 131p.

Thesis.

Radiation damage produced in gold by irradiation with fast electrons was studied. Measurements were made at 80 and 280°K, for an electron energy of 2 MeV. Results may be explained in terms of the Granato Luecke theory of dislocation pinning if it is assumed there are two dislocation systems present. Annealing experiments following irradiations at 15 and 80°K showed that defects migrate to dislocations, leading to a reduction in internal friction, over several discrete temperature intervals, centered at 50, 68, 200, 250, 320, and possibly at 110 and 300°K. Temperature regions over which increases in internal friction occurred were also observed. These are interpreted as due to defect clustering on the dislocations, leading to a decrease in the effective number of pinning points. It was found that defects migrating in Stage I (0 to 80°K) and in Stage II (80 to 240°K) have the same displacement energy of ~45eV. Results can best be explained in terms of the "one-interstitial" model, in which the interstitial defect migrates in Stage I. (UK)

Ceramics and Cermets

Corrosion and Erosion

Refer also to abstract 32998.

32947 (RFP-915) LOW TEMPERATURE ADSORPTION OF OXYGEN ON SINTERED PLUTONIUM DIOXIDE. Stakebake, J. L.; Dringman, M. R. (Dow Chemical Co., Golden, Colo. Rocky Flats

Div.). June 19, 1967. Contract AT(29-1)-1106. 9p. Dep. CFSTI.

The effect of 800°C sintering on the plutonium dioxide surface and its subsequent oxygen adsorption was investigated. The results of adsorption measurements along with a proposed adsorption mechanism are discussed. These results are compared with those obtained for the original low-temperature plutonium dioxide. (auth)

32948 COMPATIBILITY OF MIXED OXIDES AND CARBIDES WITH REFRACTORY METALS. Batey, W.; Donaldson, D. M.; Finlayson, M. B. (Dounreay Experimental Reactor Establishment, Thurso, Scotland). pp 858-87 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22-26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The compatibility of mixed (U-15% Pu) oxides and carbides with the refractory metals Mo, Nb, Ta, and W was studied in short-term tests on the Leitz hot stage microscope in the temperature range 1300 to 2100°C. Of these refractory metals, W appears to be superior to the others, being compatible up to, and probably beyond, temperatures of 1700 to 1800°C. (auth)

32949 THE COMPATIBILITY OF TYPE 316L STAINLESS STEEL WITH MIXED URANIUM-PLUTONIUM CARBIDES. Batey, W.; Donaldson, D. M.; Finlayson, M. B. (Dounreay Experimental Reactor Establishment, Thurso, Scotland). pp 888-908 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22-26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The compatability of stainless steel with mixed (U,Pu) carbides of varying C content was examined at 650 and 800°C for periods of time up to one year. Some slight C transfer was observed, but should not affect the mechanical properties of the steel. In the presence of a Na transfer medium, however, the extent of C transfer is enhanced considerably. (auth)

32950 OXIDATION OF NUCLEAR-GRADE GRAPHITE BY NITRIC ACID AND OXYGEN. Farrell, Joseph B.; Haas, Paul A. (Oak Ridge National Lab., Tenn.). Ind. Eng. Chem., Process Design Develop., 6: 277-81(July 1967). (ORNL-P-1894).

The reaction of nuclear-grade graphite with O_2 and HNO_3 solutions was studied at 275 to 300°C and 1000 to 1800 psig. O_2 was bubbled continuously through a reaction vessel containing HNO_3 and graphite. CO_2 and N_2 were the only combustion products. Approximately 1 mole of HNO_3 disappeared for every 30 moles of C consumed. Reaction rates were approximately proportional to acid normality up to 4.0N HNO_3 concentration. With 2.0N acid at 1600 psig and 300°C, a rate constant of 0.23 hr^{-1} was achieved. Air was used instead of O_2 without excessive sacrifice in rate. Corrosion in the type-347 stainless steel reactor was excessive for 4N acid. Runs made in a rocking autoclave gave much higher rates than the fixed-bed runs, either because of increased decrepitation of the graphite or improved contact between the graphite and the surrounding liquid. (auth)

Preparation and Fabrication

Refer also to abstracts 32153, 32847, 32852, 32979, 34169, and 34177.

32951 (BMI-1798) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JANUARY-MARCH 1967. Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). Apr. 1, 1967. Contract W-7405-eng-92. 98p. Dep. CFSTI.

Developments are reported for studies on: UN-PuN fuels for LMFBR applications; radiation effects on reactor cladding materials; coated-particle fuel materials; ceramic-coated Pu-base particle fuels; graphite coatings on fuel particles; UO_2-PuO_2 fuel development; and effects of high burnup on UO_2-CeO_2 and UO_2-ZrO_2 fuels. (P.C.H.)

32952 (BNWL-437) SLIP CASTING OF RARE EARTH OXIDES. Fullam, H. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1967. Contract AT(45-1)-1830. 25p. Dep. CFSTI.

The sesquioxides of Sm and Nd can be slip cast (solid casting) in plaster molds very readily. Slip preparation is simple and under optimum conditions the cast shape is easily removed from the mold. Green cast shapes having densities greater than 5 gm/cm^3 were prepared using Sm_2O_3. The only major problem encountered was the tendency of the cast shape to crack on firing. Green shapes of low initial density always cracked or spalled badly on firing. The problem was not as severe with green shapes of high density, and by using very slow heating and cooling rates, it was possible to produce fired shapes that were essentially free of flaws. By firing the green cast shapes at temperatures of 1500°C and higher, it was possible to produce Sm_2O_3 bodies having densities in excess of 7.2 gm/cm^3 (theoretical density is 7.74 gm/cm^3). Very little sintering and compaction occurred when the shapes were fired at temperatures below 1200°C. Green shapes of high initial density showed relatively even shrinkage and little distortion on firing. Low-density green shapes, however, showed very irregular shrinkage on firing in addition to cracking. The over-all potential of slip casting as a method for fabricating promethium sesquioxide into useful shapes depends primarily on the dimensional control required. In those cases where a high degree of dimensional control is required, slip casting does not appear to be practical since dimensional variations of 2 to 3% often result on firing the cast shapes. If some dimensional variations can be accommodated, however, slip casting appears to be a suitable method for producing Pm_2O_3 shapes of moderately high density (90 to 95% of theoretical). Because of radiation exposure problems, any large-scale repetitive production operation would have to be carried out in a remotely operated facility. A limited number of casts could be prepared in a gloved box, however, without excessive operator exposure. (auth)

32953 (BNWL-448) HOT PRESSING OF RARE EARTH OXIDES. Fullam, H. T.; Mitchell, C. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1967. 30p. Dep. CFSTI.

Sesquioxides of Sm and Pm were compacted to densities in excess of 95% of theoretical by pressing at temperatures of 1590°C and pressures of 5100 psi. Under similar conditions Nd_2O_3 and Pm_2O_3 compressed to slightly lower densities. In addition to the normal operating variables that affect hot-press density (time, temperature, and pressure), higher calcination temperatures before pressing lower the density that results for a given set of pressing conditions. For shapes having large length-to-dia ratios, hot pressing gives a uniform density throughout the shape length. Dimensional control is excellent and shape dia can easily be controlled to within 0.001 in. When the pressing characteristics of the oxide are known, shape length can be controlled to within 0.5%. Hot-pressed pellets of the rare earth oxides have excellent physical strength and can be handled readily without physical damage. Nd_2O_3 pellets are sensitive to atmospheric moisture, however, and must be handled accordingly to prevent their disintegration. Sm_2O_3 and Pm_2O_3 pellets, on the other hand, can be left in the open air for many days without suffering any apparent damage. Hot pressing appears to be a most practical method of fabricating Pm_2O_3 into useful shapes. (auth)

32954 (NP-16828) ELECTROCHEMICAL STUDY OF ANODIC OXIDE LAYERS OF TANTALUM. Tvarusko, Aladar (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). 1966. 99p. Dep.

Thesis.

Anodic formation of TaO_2 was studied by electrochemical methods on very thin layers and with low currents on both steady- and nonsteady-state conditions. In the steady-state the potential increased continuously with time because of the oxide-layer growth. Chemically polished, sandpapered, and untreated Ta wires were used to show that surface treatment strongly affects both steady- and nonsteady-state results. It was shown that both ionic and electronic current can flow through the oxide, with electronic most important at low currents. Evidence is discussed in detail for the change in the conduction mechanism under certain conditions. Transient behavior of tantalum under galvanostatic and constant voltage was also studied. (P.C.S.)

32955 (TID-23883) SINTERING AND GRAIN GROWTH OF THORIA GELS CONTAINING CALCIUM OXIDE. Technical Report No. XXIX. Im, Suck Joong; Wadsworth, Milton E. (Oak Ridge National Lab., Tenn. Utah Univ., Salt Lake City. Inst. of Metals and Explosives Research). Jan. 31, 1967. Contract W-7405-eng-26; Subcontract 2176. 81p. Dep. CFSTI.

The effect of Ca impurity on sintering of ThO_2 gel compacts was studied through measurements of shrinkage and grain growth. ThO_2 gels with various Ca concentrations were obtained by adding calcium nitrate up to 1% in weight. The average grain sizes of initial ThO_2 gels were in the range of 60 to 85 Å, and the maximum average grain size during sintering at 850°C was 300 Å. Grain boundary diffusion was found to explain the sintering data well except for higher temperatures above 850°C. Analysis of shrinkage data was done by use of a computer. The results showed increased sintering rate as the Ca concentration increased. The average activation energy, 45 kcal/mole, was virtually the same, within experimental error, as the result obtained by Daniels for plain gel. The effect of atmosphere on grain growth of plain gel compacts during sintering was studied in air and H_2 atmospheres. Results showed a slightly enhanced rate of grain growth in the H_2 atmo-

sphere. The higher the Ca concentration the faster was the grain growth rate in air. At above 850°Ç, abnormal grain growth was observed when 1% Ca was present. From a correlation of grain growth and sintering, it was indicated that sintering occurred at normal rates (i.e., the grain boundary diffusion model was obeyed) only in the range of normal grain growth, below approximately 850°C for the 1% Ca–ThO_2 gels. (auth)

32956 INFLUENCE OF POWDER HEAT TREATMENT ON THE SINTERING OF $(UPu)O_2$. Adwick, A. G.; Batchelor, E. R. (Dounreay Experimental Reactor Establishment, Thurso, Scotland). pp 623-38 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

A series of $(UPu)O_2$ powders was prepared with surface area values between 2 and 32 m^2/g by variation of the heat treatment conditions in either H_2 or CO_2. An equivalent surface area was obtained at lower temperatures in CO_2 than in H_2. These powders were compacted and sintered. The data are discussed in relation to rearrangements within particles, aggregation of crystallites and sintering of particles. If the heat treatment temperatures do not greatly exceed that at which sintering commences, variations in pressed density do not affect the sintered density. Powder aggregation, however, as indicated by the tap and pressed density, was found to exert a resistance to consolidation and cause the dependence of sintered density on pressing pressure. (auth)

32957 PREPARATION OF UO_2–PuO_2–ZrO_2 FUELS. Caldwell, C. S.; Puechl, K. H.; Fisher, F. D.; Roth, J. (Nuclear Materials and Equipment Corp., Apollo, Pa.). pp 654-68 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Prior to the development of economically competitive fast breeder reactors, it is desirable to recycle Pu in thermal reactors and perhaps, more specifically, in the same reactors in which the Pu is produced. Since the lattice spacing in such reactors has been more or less optimized to allow the economic utilization of slightly enriched U, such lattices are generally not suitable for the economic utilization of Pu. The effects of the addition of a nuclearly innocuous material, ZrO_2, to UO_2–PuO_2 fuel are, therefore, being studied. By the appropriate addition of such a diluent, the Pu-to-moderator ratio can be adjusted to an optimum value even though the lattice spacing is fixed by the core structure of the particular reactor in which Pu recycle is intended. A number of fuel preparation routes are being investigated, and appropriate irradiation specimens are being prepared. The various powder preparation routes are described as are the characteristics of the materials. The results of sintering trials are also presented along with pellet characteristics and physical property data. (auth)

32958 SOME EXPERIMENTS ON THE PREPARATION AND FABRICATION OF UC AND (UPu)C, THE PREPARATION OF CARBIDES BY CARBOTHERMIC REDUCTION OF OXIDES IN FLOWING ARGON; THE FABRICATION OF CARBIDES BY SKULL ARC-MELTING. Evans, J. P.; Harrison, J. D. L.; Isaacs, J. W.; North, J. M.; Roberts, W. G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 673-96 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Recent developments at Harwell concerning preparation and fabrication processes for mixed U–Pu carbides are reported. Studies on the 25 to 50 g/hr scale of the preparation of carbides and oxycarbides were made using an apparatus in which the carbothermic reduction under Ar of the appropriate oxides proceeds in a bed that is continuously moving through a furnace. The effect of mixing the reactants under various conditions and of CO overpressure on the efficiency of the carbide- or oxycarbide-forming processes was investigated. This demonstrated the feasibility of such a process as an alternative to other routes requiring single- or multistage vacuum treatments. Skull melting offers an alternative fabrication method to sintering for production of high-density carbide. Criticality considerations for Pu limit the scale of melting to 500 g. Also, the casting of relatively thin rods (0.25 in. diameter) poses special problems. Particular attention was paid to choice of feed material, composition control, and the problems of increasing the yield of sound material. (auth)

32959 PREPARATION AND PROPERTIES OF SOME GROUPS V AND VI COMPOUNDS OF PLUTONIUM. Handwerk, J. H.; Kruger, O. L.; Moser, J. B. (Argonne National Lab., Ill.). pp 739-50 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

High-purity PuS and PuP were made by first preparing a fine Pu powder. This powder was produced by repeatedly hydriding and dehydriding pieces of Pu metal. The fine Pu powder was reacted with either H_2S or H_3P gas to form the sulphide or phosphide, respectively. The stoichiometry and purity of the compounds made were verified by x-ray and chemical analysis. Among the physical properties being studied on high-density sintered specimens are melting point, thermal expansion, and electric conductivity. Thermal conductivity and heat capacity as a function of temperature will also be measured for these compounds. (auth)

32960 PREPARATION AND STUDIES OF SOME PROPERTIES OF PLUTONIUM MONOCARBIDES. Reshetnikov, F. G.; Artamonov, V. V.; Gurvich, M. G.; Kuznetsova, V. G.; Bagrova, V. I.; Alekseev, O. A.; Chebotarev, N. T.; Kuzin, N. I. (Academy of Sciences, Moscow). pp 751-67 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The processes used to prepare PuC by the interaction of PuH_4 with C and to fabricate it into dense bodies were studied. Investigations included examination of the effect of Ni additions on the density of PuC, and the influence of C on nickel distribution in sintered PuC specimens. The thermal expansion coefficient was measured for PuC. Some data are given on PuC compatibility with promising structural materials. (auth)

32961 NEW MASKING TECHNIQUE FOR SEMICONDUCTOR PROCESSING. Brown, D. M.; Engeler, W. E.; Garfinkel, M.; Heumann, F. K. (General Electric Co., Schenectady, N. Y.). J. Electrochem. Soc., 114: 730-3(July 1967).

A new masking method utilizing an intermediate integral Mo film is described. The Mo mask is a practical method for etching very high resolution patterns in passivating dielectric films including films of Si_3N_4 which heretofore have been unmanageable. The Mo film has much better masking properties than the photoresists now used. (auth)

32962 PRODUCTION OF SINTERABLE, SLIGHTLY ENRICHED URANIUM DIOXIDE IN FLUIDIZED-BED FURNACES. Hackstein, K. G.; Pirk, H. (NUKEM, Wolfgang, Ger.). Kerntechnik, 9: 261-3(June 1967). (In German).

The reaction of slightly enriched UF_6 with gaseous NH_3 and CO_2 in water led to the precipitation of ammonium uranyl carbonate. This precipitate was directly reduced without intermediate drying in a fluidized-bed furnace resulting in an UO_2 powder of good pressing and sintering behavior. (auth)

32963 HEAT OF FORMATION OF URANIUM CARBIDE. Storms, E. K.; Huber, E. J. Jr. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Nucl. Mater., 23: 19-24(July 1967). (LA-DC-8434).

The heat of combustion for $UC_{0.996 \pm 0.005}$ and $UC_{1.032 \pm 0.005}$ was determined and -23.3 ± 0.9 and -23.0 ± 1.0 kcal/mole were calculated as the respective heats of formation at 298.15°K. By comparing this with previous combustion and vapor pressure measurements, the change in the heat of formation as a function of composition can be defined. Strong evidence is provided that the heat of vaporization of U is near 126.5 kcal/mole at 298.15°K. (auth)

32964 COATING OF FEED- AND BREED-PARTICLES IN A FLUIDIZED BED UNDER REDUCED PRESSURE. Huschka, H.; Popp, W. (NUKEM, Wolfgang, Ger.). J. Nucl. Mater., 23: 109-10(July 1967).

Difficulties in coating fuel materials in fluidized beds were overcome by coating at reduced pressure. By installation of a vacuum pump at the gas outlet and valves at the gas inlet the pressure in the reactor tube could be kept below 760 torr. It was therefore possible to accomplish perfect fluidization with a considerably smaller amount of carrier gas. The coating of $(U,Th)C_2$ particles is considered. (M.C.G.)

32965 PREPARATION OF THORIUM OXIDE MICROSPHERES. IV. EXPERIMENTS WITH MIXTURES OF ETHYL AND ISOBUTYL ALCOHOL. Yamazaki, Yasaburo; Yoshida, Kenzo; Komori, Matuso (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 9: 326-31(June 1967). (In Japanese).

Experiments on the preparation of ThO_2 microspheres using mixtures of ethyl and isobutyl alcohol instead of isopropyl alcohol were carried out to verify a proposed mechanism of microsphere formation. The mixed alcohol–water–ammonium nitrate system had a

different type of equilibrium diagram from that of the isopropyl alcohol–water–ammonium nitrate system, and the shape of the equilibrium curve possessing minimum points varied with the composition of the mixed alcohol. Most of the results obtained on microsphere preparation with various ammonium nitrate concentrations in thorium hydroxide sols at various mixed alcohol compositions showed fair agreement with the microsphere formation region estimated from the equilibrium diagram. The amorphous gel formation in the expected microsphere formation region may be explained from the oil in water type of emulsion formed by the mixing of the two liquid phases. The average particle diameter of the ThO_2 microspheres may be controlled within a range of 4 to 20 μ at constant injection velocity by changing the mixed alcohol composition of the mixed alcohol or the ammonium nitrate concentration in the sol. (auth)

32966 PREPARATION OF THORIUM CARBIDES. Imai, Hisashi; Hosaka, Shinobu; Naito, Keiji (Japan Atomic Energy Research Inst., Tokyo). J. Amer. Ceram. Soc., 50: 308-11 (June 21, 1967).

Some factors influencing the formation of ThC_2 from a mixture of ThO_2 and graphite powder were studied. ThC_2 formation was examined using ThC_2O_4 in addition to ThO_2. The effects of the molecular ratio of the reactants, reaction temperature, extrinsic properties (such as surface area, defects, and crystallinity of the materials), and the ambient pressure were examined. The molecular ratio of the reactants gave the most important effect on the composition of the final products. ThC_2 was formed from a mixture having a molecular ratio (C/ThO_2) of more than three and the reaction rate then obeyed the parabolic rate equation. To form ThC, it is necessary to use a mixture having a ratio less than four. A tentative explanation of the reaction mechanism for ThC formation is given. (auth)

32967 TANTALUM OXIDE FILMS PREPARED BY OXYGEN PLASMA ANODIZATION AND REACTIVE SPUTTERING. Vratny, F. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Amer. Ceram. Soc., 50: 283-7(June 21, 1967).

Two processes of glow-discharge anodization and dc diode reactive sputtering were investigated for the formation of TaO_2 films. Dielectrics up to a maximum thickness of 3000 Å were prepared by these methods with equal or larger than anticipated capacitance per unit area and dielectric strengths of about one third of the anodically formed TaO_2. The dc diode reactive sputtering process produced thickness variations over 50 cm^2 of 4 to 20% compared with 4 and 1%, respectively, for glow-discharge and aqueous anodization. All vacuum methods at present are limited in applicability because of lower dielectric strength and lower formation rates. (auth)

32968 ABOUT NEW MODIFICATIONS OF ZrO_2 AND HfO_2 PREPARED UNDER HIGH PRESSURE. Bendeliani, N. A.; Popova, S. V.; Vereshchagin, L. F. (Inst. of High Pressure, Moscow). Geokhimiya, No. 6, 677-83(June 1967). (In Russian).

Under high pressure (40 to 110 kbar) and at room temperature to 1700°C, new phases of ZrO_2 and HfO_2 were obtained. These phases are metastable at ordinary conditions. The experiments were mainly carried out in hermetic ampules, which were able to hold water. On the basis of x-ray data it was found that both new polymorphs have orthorhombic unit cell containing 4 molecules with dimensions: for ZrO_2II: a = 5.110 ± 0.008 Å, b = 5.073 ± 0.008 Å, c = 5.267 ± 0.008 Å; for HfO_2II: a = 5.056 ± 0.006 Å, b = 5.006 ± 0.006 Å, c = 5.224 ± 0.006 Å; and Space group–D_{2h}^{4} = $P\,2_12_12_1$. Their densities determined by the x-ray method are d = 5.99 g/cm^3 for ZrO_2II and 10.58 g/cm^3 for HfO_2II. The reverse transition was obtained by heating ZrO_2II and HfO_2II at 500°C for four hours. (auth)

32969 POLISHING POROUS MATERIALS. King, A. G.; Fuchs, Karl (Zirconium Corp. of America, Cleveland). J. Amer. Ceram. Soc., 50: 328-9(June 21, 1967).

A technique is reported for polishing porous ZrO_2 by impregnating the ZrO_2 with low-melting glass frits of lead borosilicate. The technique was also used on an alumina ceramic that had a chalky consolidation. Advantages over the conventional method of impregnating with epoxy resins before polishing are discussed. (P.C.S.)

32970 LOCALIZED COOLING IN FLUX CRYSTAL GROWTH. Chase, A. B.; Osmer, Judith A. (Aerospace Corp., El Segundo, Calif.). J. Amer. Ceram. Soc., 50: 325-8(June 21, 1967).

Large crystals of ZnO, Al_2O_3, Ga_2O_3, ThO_2, $Y_3Ga_5O_{12}$, $ZnGa_2O_4$, and ZrO_2 were grown from $PbO–PbF_2$ flux systems using a temperature gradient and localized cooling induced by a jet of cold air directed on the crucible bottom. The temperature gradients in the crucible were much less than that in the furnace. The technique is described, and crystals grown with and without a temperature gradient are compared. (auth)

32971 SINTERING OF WC POWDER AND WC–Co MIXED POWDER UNDER HIGH PRESSURE. Kudaka, Katsuya; Konno, Hiroshi; Matoba, Toshio (Mitsubishi Metal Mining Co. Ltd., Omiya, Japan). Nippon Kinzoku Gakkaishi, 31: 177-82(1967). (In Japanese).

WC powder and WC–Co mixed powder (Co 1.5 and 6 wt %) were sintered at 15 to 45 kbar and 800 to 1800°C under high pressure and temperature, respectively. As sintering temperature increased, the hardness of the sintered bodies increased and then decreased after attaining a maximum value. The obtained hardness was an appreciably high value of 2500 to 3000 kg/mm^2 in micro-Vicker's hardness. The increase in hardness was mainly due to adhesion between particles, inhibition of grain growth, and increase of microstrain in crystals, whereas the decrease in hardness was mainly due to grain growth and the relaxation of strain by high temperature. Sintering processes of WC powder and WC–Co mixed powder under high pressure were divided into three sintering temperature stages. In the first stage no adhesion between particles nor grain growth occurred and consequently no increase in hardness was observed. In the second stage the adhesion between particles proceeded, but grains hardly grew and the hardness increased to attain a maximum value. In the third stage grains grew considerably and the hardness decreased. In the sintering of WC–Co mixed powder, the 3rd stage was above the eutectic temperature of about 1350°C, which was almost independent of the Co content and pressure. Sintering of WC–Co mixed powder proceeded mainly by plastic flow in the second stage and by solution-precipitation in the third stage. In the sintering of WC powder, the third stage remarkably shifted to high temperature with pressure. The sintering proceeded mainly by plastic flow in the second stage and by diffusion in the third stage. (auth)

32972 PREPARATION AND PROPERTIES OF URANIUM MONOPHOSPHIDE. Driscoll, J. L. Manchester, Eng., Univ. of Manchester, March 1967. 412p.

Thesis.

Previous work on the preparation of UP (a possible nuclear fuel) is reviewed. Reactions taking place in the preparation of UP by direct reaction between U and P were investigated. Each batch of material was characterised by sieve, chemical, and x-ray analysis. Fabrication by cold pressing and sintering, and by hot pressing, was investigated. The structure and properties of UP are discussed and compared with other nuclear ceramic materials. Conclusions were drawn on the potential of UP as a nuclear fuel. UP appears to have a similar potential as a nuclear fuel material as UC, UN, and US. Its oxidation resistance is superior, and (Th,U)P solid solution may possess potential as a high temperature fuel in thermal breeder reactors. Suggestions for future studies are made. (269 references.) (UK)

32973 METHOD OF STABILIZING PLUTONIUM DIOXIDE. Pritchard, William C. (to U. S. Atomic Energy Commission). U. S. Patent 3,331,683. July 18, 1967.

A process was developed for stabilizing powdered plutonium dioxide by adding a stabilizing agent selected from the class of tungsten and molybdenum powders; the molybdenum is added in an amount of about 2 wt % and the tungsten is added in an amount of about 2 vol %. Then mixing, compacting, and sintering are carried out. (AEC)

32974 METHOD FOR PREPARING METAL OXIDE MICROSPHERES. Haas, Paul A.; Clinton, Sam D. (to U. S. Atomic Energy Commission). U. S. Patent 3,331,898. July 18, 1967.

Gel microspheres selected from urania, thoria, plutonia, and zirconia are prepared by an improved process wherein an aqueous sol stream of the compounds is formed into sol droplets of from 200 to 500 microns in size by passing the sol stream into an organic drying liquid stream at an angle to its direction of flow to effect a high shearing force on the sol and droplet formation. (AEC)

Properties Evaluations

Refer also to abstracts 32854, 32959, 32960, 32997, 34108, 34109, and 34176.

32975 (TID-23882) SHRINKAGE MEASUREMENTS OF THORIA COMPACT-DT CONTAINING ADDED IMPURITIES. Technical Report No. XXXII. Im, S. J.; Wadsworth, M. E. (Oak Ridge National Lab., Tenn. Utah Univ., Salt Lake City. Inst. of Metals and Explosives Research). Jan. 31, 1967. Contract W-7405-eng-26; Subcontract 2176. 7p. Dep. CFSTI.

The shrinkage data for plain gel and DT-samples after sintering for about 300 min at 700°C and 900°C are presented and comparisons recorded. The increased shrinkage from 700°C to 900°C of the samples with added sulfate or phosphate was less than that of plain gel, and the shrinkage at given temperatures decreased as the

concentration of sulfate or phosphate impurity in thoria gel was increased. (J.C.W.)

32976 (UCRL-17411) KINETICS AND MECHANISMS OF THE DIFFUSION OF IRON AND NICKEL IN SINGLE CRYSTALS OF MAGNESIUM OXIDE. Blank, Stuart L. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1967. Contract W-7405-eng-48. 141p. Dep. CFSTI.

Thesis.

The diffusion kinetics in the Fe–MgO, NiO–MgO, and Fe_2O_3–MgO systems were investigated with particular emphasis placed on the relationship between atomistic mechanisms and structural changes. The existence of Fe^{3+} ions and their location in the lattice in the Fe–MgO (vacuum) and Fe_2O_3–MgO (air) systems were determined by the use of electron paramagnetic resonance, optical spectroscopy, and Moessbauer analyses. The location of Fe^{2+} in the systems was investigated using optical spectroscopy. The occurrence of Fe^{3+} ions in tetrahedral symmetry in the MgO lattice was associated with structural changes responsible for variations in the activation energy for diffusion in the Fe–MgO and Fe_2O_3–MgO systems. The presence of chemically created vacancies in all of the systems increased the diffusivities. The concentration vs penetration curves were obtained using the electron microprobe analyzer. The diffusion studies showed that in a vacuum Fe reacts with MgO at 1100 to 1350°C according to the equation: XFe + MgO ⇌ Fe_xO + Mg↑. The subsequent diffusion of Fe into MgO was found to follow the relations: at 1150°C, $D = 8.1 \times 10^{-12}\ e^{0.34\delta\ [Fe]}$; at 1250°C, $D = 1.6 \times 10^{-11}\ e^{0.39\delta\ [Fe]}$; and at 1350°C, $D = 2.4 \times 10^{-11}\ e^{0.43\delta\ [Fe]}$. The temperature dependence was found to be: at 5 at. % Fe, $D = 6.34 \times 10^{-7}\ e(-29.6$ kcal/RT); at 10 at. % Fe, $D = 4.49 \times 10^{-6}\ e(-32.9$ kcal/RT); at 15 at. % Fe, $D = 5.04 \times 10^{-5}\ e\ (-37.7$ kcal/RT); and at 20 at. % Fe, $D = 8.40 \times 10^{-4}\ e(-43.5$ kcal/RT). The diffusion results in the NiO–MgO system in a vacuum showed no concentration dependence of either the D_0 term or the activation energy and are represented by $D = 9.82 \times 10^{-6}$ exp (−45.5 kcal/RT). However in air the diffusivity was concentration dependent but the activation energy was found to be constant. The air results are: at 1200°C, $D = 1.75 \times 10^{-12}\ e^{0.053\delta\ [Ni]}$; at 1300°C, $D = 4.1 \times 10^{-12}\ e^{0.053\delta\ [Ni]}$; at 1370°C, $D = 7.6 \times 10^{-12}\ e^{0.053\delta\ [Ni]}$; and at 1400°C, $D = 1.05 \times 10^{-11}\ e^{0.053\delta\ [Ni]}$. The temperature dependence was found to follow the relationships: at 10 at. %, $D = 6.31 \times 10^{-6}$ exp (−42.8 kcal/RT); at 20 at. %, $D = 1.05 \times 10^{-5}$ exp (−42.8 kcal/RT); at 30 at. %, $D = 1.96 \times 10^{-5}$ exp (−42.8 kcal/RT); and at 40 at. %, $D = 3.16 \times 10^{-5}$ exp (−42.8 kcal/RT). The diffusion kinetics in the Fe_2O_3–MgO system were found to obey the relation: $D = 8.83$ exp (−74.6 kcal/RT) in the temperature range from 1200 to 1400°C. This relation is for an average composition in the diffusion zone resulting from the approximation used to solve the 3-phase 2-moving-boundaries diffusion problem. (auth)

32977 MECHANICAL PROPERTIES AND COMPATIBILITY OF URANIUM–PLUTONIUM CARBIDES. French, P. M.; Hodkin, D. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 697-720 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The mechanical properties of both sintered and skull-cast U–Pu carbides were measured at temperatures up to 900°C. Hardness, compression, indentation creep, and the relief of internal stresses at 1400 to 1600°C were studied. The mixed carbide was compatible with Type 316L stainless steel up to 900°C, although slight surface carburization was observed. The introduction of a sodium bond can lead to gross carburization of the steel in the presence of hyperstoichiometric carbide. Compatibility studies on nickel-based alloys showed reactions to occur at as low as 650°C. (auth)

32978 PROPERTIES OF PLUTONIUM MONONITRIDE AND ITS ALLOYS. Pardue, W. M.; Storhok, V. W.; Smith, R. A. (Battelle Memorial Inst., Columbus, Ohio). pp 721-38 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Preparation of dense bodies of stoichiometric PuN and systems of this compound with UN, TiN, and ThN is described. Outlines of some of the simpler phase relationships in these systems are presented. Physical property measurements of PuN were undertaken and are compiled, including determinations of the chemical reactivity potential between PuN and various metallic claddings, liquid metals, organic acids, and gases. The previously reported phenomenon of volatility, or decomposition, was more completely analyzed and compared with that of other Pu materials. Other properties such as thermal expansion, useful for reactor design and reliability considerations were included. Cursory measurements of properties for those alloys of PuN that possess potential for breeder or converter reactor systems were undertaken. (auth)

32979 SOME STUDIES OF THE HIGH TEMPERATURE BEHAVIOUR OF PuO_2 AND PuO_2–UO_2 MIXTURES. Berggren, G.; Forsyth, R. S. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 828-34 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Results of experiments carried out on PuO_2, and on PuO_2–UO_2 mixtures prepared by various preparative routes including physical mixing in the range 1 to 25% PuO_2 are described. Observations were made up to temperatures of about 1600°C by means of TGA, DTA, and dilatometry; confirmatory work included density determinations and x-ray and metallographic examination. Various gas atmospheres were used. Of particular interest are experiments in reducing atmospheres for study of lower O/metal phases, and also the stability of sintered pellets containing higher amounts of Pu in oxidizing atmospheres. (auth)

32980 THERMODYNAMIC AND PHASE STUDIES FOR PLUTONIUM AND URANIUM–PLUTONIUM OXIDES WITH APPLICATION TO COMPATIBILITY CALCULATIONS. Markin, T. L.; McIver, E. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 845-57 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

A high-temperature x-ray camera was used to study the phase equilibria in the Pu–O and U–Pu–O systems and the results are reviewed briefly. A single phase nonstoichiometric fluorite type oxide exists over wide temperature and composition ranges for mixed U–Pu oxides containing between 10 and 30% Pu. Thermodynamic data were obtained for Pu–O and U–Pu–O at temperatures between 700 and 1140°C using a high-temperature galvanic cell employing solid electrolytes reversible to oxygen ions only. The measurements show that the O_2 potential changes very rapidly with composition as the stoichiometric composition is approached. The thermodynamic data for PuO_{2-x} agree with the suggested phase diagram and an extrapolation was made from 700°C to room temperature that is consistent with the phase diagram. The thermodynamic data for the (U,Pu) oxides can be used to predict the composition attainable in various reducing gas mixtures at different temperatures and also the compatibility of the oxides with metals. Relevant values for the O_2 potential of oxide films on stainless steels are of use in such calculations. (auth)

32981 TECHNIQUES FOR THE MEASUREMENT OF ENTROPY AND THEIR APPLICATION TO SOME URANIUM COMPOUNDS. Martin, J. F. (National Physical Lab., Teddington, Eng.). Proc. Brit. Ceramic Soc., No. 8, 1-13(June 1967).

Equipment for the measurement of heat capacities and heats of transition at 10 to 450°K is described. A special feature of the apparatus is the use of automatic devices for recording the experimental data on punched tape, which is then processed by computer. Results of measurements on uranium carbides (UC, $UC_{1.01}$, and U_2C_3) and uranium nitrides ($UN_{1.01}$, $UN_{1.59}$, $UN_{1.73}$) are summarized. (auth) (UK)

32982 THERMODYNAMIC DATA OF UN_x (x = 1.5 – 1.75). Naoumidis, A.; Stoecker, H. J. (Kernforschungsanlage, Juelich, Ger.). Proc. Brit. Ceramic Soc., No. 8, 193-200(June 1967).

The nitriding of cubic U_2N_3 (Mn_2O_3 structure) leads to products that can be considered as solid solutions of cubic U_2N_3 and the hypothetical UN_2 (fluorite structure). Maximum N content at atmospheric pressure corresponds to $UN_{1.75}$, and at high pressures to $UN_{1.81}$. Equilibrium pressures were measured at different temperatures, and thermodynamic data for compositions between $UN_{1.5}$ and $UN_{1.75}$ are presented. (auth) (UK)

32983 VAPORIZATION OF DIMOLYBDENUM CARBIDE. Fries, R. J. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Chem. Phys., 46: 4463-9(June 1, 1967). (LA-DC-8089).

The vaporization behavior of Mo_2C was investigated over the temperature range 2125 to 2550°K by Langmuir experiments utilizing an induction-heated, ultrahigh vacuum thermobalance. A congruently vaporizing composition of $MoC_{0.45}$ was found at temperatures from 2250 to 2300°C. The total evaporation rate increases and the heat of evaporation decreases as the carbon-to-metal ratio of the sample decreases from 0.49 to 0.44. A mass-spectrometric examination of the evaporate from $MoC_{0.45}$ did not reveal any Mo_xC_y molecules. Therefore, evaporation by decomposition is assumed. If monatomic gaseous species and unit

evaporation coefficients are also assumed, the pressures over $MoC_{0.49}$ are log P_{Mo} (atm) = 7.112 ± 0.139 − (3.420 ± 0.033) (10^4/T) and log P_C (atm) = 6.351 ± 0.139 − (3.420 ± 0.033) (10^4/T). The errors quoted are standard deviations. The heat of formation at 298°K of $MoC_{0.49}$ is −4.9 kcal/mole from third-law calculations, in good agreement with the −5.5 kcal measured calorimetrically. (auth)

32984 SELF-DIFFUSION OF URANIUM IN URANIUM DIOXIDE: ROLE OF STOICHIOMETRY DEVIATION AND GRAIN BOUNDARIES. Marin, Jean-Francois; Michaud, Henri; Contamin, Pierre (CEN, Grenoble, France). Compt. Rend., Ser. C, 264: 1633-6(May 17, 1967). (In French).

The coefficient of self-diffusion of U in UO_2 was measured at 1500°C for a series of samples of UO_{2+x} showing variable deviations with respect to the x stoichiometry; it varies approximately according to the law $D \propto x^2$. Autoradiographic examinations showed evidence of significant intergranular diffusion for all the superstoichiometric samples. (tr-auth)

32985 WEAK FERROMAGNETISM IN ANTIFERROMAGNETIC UO_2. Hambourger, P. D.; Marcus, J. A. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 157: 438-40(May 10, 1967).

A nearly isotropic weak ferromagnetism has been observed by the torque method in single crystals of UO_2 below the Néel temperature. Measurements were made of remanence produced by cooling samples from $T > T_N$ down to 4.2°K in fields up to 32 kOe or by cooling in zero field to 4.2°K followed by the isothermal application of the field. The largest remanence observed was 5.7×10^{-2} emu/g. Upon warming from 4.2°K toward T_N, the remanence diminishes with increasing rapidity and then levels off abruptly at T_N at a small residual value. The curve of remanence versus temperature is markedly different for the two types of magnetic treatment. (auth)

32986 MONOXIDE-TYPE COMPOUNDS OF URANIUM AND PLUTONIUM: I. OXYCARBIDES. Taylor, K. M.; Andersen, J. C.; Strasser, A.; Stahl, D.; Forbes, R. L. (Carborundum Co., Niagara Falls, N. Y. United Nuclear Corp., Elmsford, N. Y.). J. Amer. Ceram. Soc., 50: 321-5(June 21, 1967).

Oxycarbides having the face-centered-cubic MO-type structure were formed by the controlled reduction of mixtures of PuO_2 and UO_2 in He and in vacuum. C, UC, and U were used as reducing agents. C appeared to be necessary to stabilize the monoxide structure. The maximum O content for essentially single-phase $(U_{0.9}Pu_{0.1})(O_xC_{1-x})$ is x = 0.4. Oxycarbide compositions with higher O contents (approaching x = 0.6) can be produced but these products are multiphase containing appreciable quantities of a dioxide, MO_{2-x} in C reduction, and MO_{2-x} plus metal in U plus UO reduction. The single-phase oxycarbides lack sufficient water-corrosion resistance to be used as fuels in water-cooled reactors; however, their thermal conductivity appears to be higher than that of the dioxide fuels. (auth)

32987 ENTHALPY AND HEAT CAPACITY OF THE YTTRIUM SESQUIOXIDE AND CERIUM DIOXIDE AT HIGH TEMPERATURES. Yashvili, T. S.; Tsagareishvili, D. Sh.; Gvelesiani, G. G. (Inst. of Metallurgy, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 46: 409-13(May 1967). (In Russian).

A mixing method was used in a calorimeter for measuring the enthalpy of Y_2O_3 and CeO_2 at 298.15 to 1600°K. Empirical equations for the enthalpy and intrinsic heat capacity were obtained as functions of the temperature. (R.V.J.)

32988 HIGH-TEMPERATURE CREEP AND DISLOCATION ETCH PITS IN POLYCRYSTALLINE BERYLLIUM OXIDE. Barmore, Willis L.; Vandervoort, Richard R. (Univ. of California, Livermore). J. Amer. Ceram. Soc., 50: 316-20(June 21, 1967).

Compressive creep of high-density polycrystalline BeO was investigated at 1850 to 2050°C. Creep rate was dependent on the applied stress to the 2.5 power, and the apparent activation energy for creep was 145 kcal/mole. Etch pit studies showed that the dislocation density in tested specimens was two orders of magnitude greater than that in as-sintered material. The diffusion process controlling creep was ascribed to volume diffusion of the anion. The deformation behavior was governed by dislocation motion. (auth)

32989 HOT HARDNESS OF SELECTED BORIDES, OXIDES, AND CARBIDES TO 1900°C. Koester, R. D.; Moak, D. P. (Battelle Memorial Inst., Columbus, Ohio). J. Amer. Ceram. Soc., 50: 290-6(June 21, 1967).

The hot hardness of TiB_2, W_2B_5, ZrB_2, HfB_2, ZrO_2, Al_2O_3, NbC, TiC, TaC_{1-x}, HfC_{1+x}, $(Ta_{0.8}Hf_{0.2})C_{1+x}$, W_2C, and $(W_{0.65}Cr_{0.14}Re_{0.14}Ta_{0.07})_2C$ of <95% density was determined to temperatures approaching 1900°C. In all cases, the hardness decreased rapidly with increasing temperature. The data are compared with those in literature. (auth)

32990 PROPERTIES OF HOT-PRESSED FERROELECTRIC ALKALI NIOBATE CERAMICS. Haertling, G. H. (Sandia Corp., Albuquerque, N. Mex.). J. Amer. Ceram. Soc., 50: 329-30 (June 21, 1967).

Data on the properties of the binary $(Na,K)NbO_3$ system and the ternary $(Na,K,Li)NbO_3$ system are reported. Small signal capacitance and dissipation factor were measured. Planar coupling was determined by the resonance method. Large signal hysteresis loop measurements of remanent polarization and coercive field were obtained with a dc hysteresis-loop plotter. Theoretical densities were computed after x-ray powder diffraction patterns were obtained for the binary system. X-ray powder diffraction patterns for compositions in the ternary system indicated that a mixture of several compounds was present in all specimens except $LiNbO_3$. No attempt was made to identify all the phases present, but it was evident that no large areas of solid solution were present within the ternary system. (P.C.S.)

32991 INVESTIGATIONS OF URANIUM–PLUTONIUM–TITANIUM–CARBON COMPOUNDS. Milet, C. Mem. Sci. Rev. Met., 44: 261-6(Mar. 1967). (In French).

Addition of Ti improves properties of the (U,Pu)C monocarbide and it inhibits formation of the free metal (U,Pu) phase as well as the higher carbides. Ti increases the resistance to atmospheric corrosion, raises the thermal conductivity and improves the compatibility with the stainless steel. (auth)

32992 ISOTHERMAL YOUNG'S MODULUS OF UO_2 AND UO_2–MO-CERMETS. Claussen, N. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Ber. Deut. Keram. Ges., 44: 267-70 (June 1967). (In German).

Young's modulus of UO_2–Mo-cermets was determined by diametral-compression. The cylindrical samples necessary for this test were vacuum hot-pressed at 1500°C and 400 kg/cm². According to cermet composition, densities between 91.5% (Mo) and 97.0% (UO_2) were achieved. Measurements on 10 UO_2-samples of the same density (97.0%) resulted in a mean of 21.200 kg/mm² with a variation of 1%. Dependencies of Young's modulus on density were determined. Results of different compositions were recalculated for zero porosity assuming same porosity in the two phases of the cermet as in the two single components. A plot of these values versus composition lies below the theoretical predictions of Paul and Hashin which is related to bad wetting behavior between the phases and a low cohesion resulting from this. (auth)

Structure and Phase Studies

Refer also to abstracts 32922, 32979, 32980, 33539, and 34154.

32993 (TID-23884) EXTENDED STUDY OF GRAIN GROWTH OF THORIA GEL. Technical Report Number XXXIII. Im, Suk Joong; Wadsworth, Milton E. (Oak Ridge National Lab., Tenn. Utah Univ., Salt Lake City. Inst. of Metals and Explosives Research). Jan. 31, 1967. Contract W-7405-eng-26; Subcontract 2176. 65p. Dep. CFSTI.

In addition to grain size determination, during presoaking and firing, using electron microscopy and x-ray line broadening techniques, the density change was studied on each sample fired in the ambient atmosphere. Thoria gel samples were presoaked at 900°C for several hours in N_2 and H_2 atmospheres and the densities were measured by means of toluene displacement. Considering the densities (approximately 9.2) of the samples presoaked for 4 hours in N_2 and H_2 could approach the theoretical density when they are fired, examinations of average grain size as a function of time were carried out in N_2 and H_2 atmospheres. Similar studies were carried out in N_2 atmospheres at 1150°C after presoaking for 4 hours in N_2 atmospheres. Firing in H_2 produces enhanced grain growth and rate of densification, and the measured density change was not greatly affected by grain coarsening and grain refinement. Erratic grain growth was observed in the experiments under various conditions but was not observed for the samples fired at 1150°C for 800 minutes in N_2 atmosphere after presoaking at 900°C for 4 hours in N_2 atmosphere, and for the samples fired at 1050°C for 800 minutes in H_2 after 4 hours presoaking in H_2 atmosphere. (auth)

32994 CONSTITUTIONAL STUDIES ON THE TERNARY SYSTEM PLUTONIUM–MOLYBDENUM–CARBON, PLUTONIUM–SILICON–CARBON, AND PLUTONIUM–THORIUM–CARBON. Dalton, J. T.; Potter, P. E.; Shaw, J. L. (Atomic Energy Research Establishment, Harwell, Eng.). pp 775-805 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Ternary systems containing Pu and C together with Mo, Si, or

Th were investigated, mainly in the regions containing 40 to 70 wt % C and at temperatures from 1000°C to the liquidus. The existence of two ternary compounds in the Mo system was established: $PuMoC_2$ transforming to the $UMoC_2$ structure above 1680°C, and η with the approximate composition $Pu_4Mo_3C_3$. The following tie lines were confirmed: $PuMoC_2$ to Pu_2C_3, PuC, η and Mo_2C, and η to PuC, Mo, Mo_2C, and $PuMoC_2$. The liquidus of the PuSi-PuC section is a minimum at ~1400°C and close to $PuC_{0.5}Si_{0.5}$ where it crosses the Pu_2C_3–PuSi eutectic valley. The three-phase triangles PuSi–PuC–Pu_2C_3; PuSi–Pu_2Si_3–Pu_2C_3 and Pu_2C_3–Pu_2Si_3–SiC exist. No ternary compounds were detected. Complete solid solubility exists between cubic ThC_2 and PuC_2. Eutectoidal horizontals exist on the ThC_2–PuC_2 tie at 1240°C (~55 to 71% PuC_2) and 1160°C (~59 to 77% PuC_2) corresponding to the transformations of cubic dicarbide to tetragonal and then to monoclinic forms with the simultaneous formation of a mixed sesquicarbide. (auth)

32995 STUDY OF PLUTONIUM OXIDES AND THEIR SOLUBILITY IN URANIUM DIOXIDE. Dean, G. (CEN, Fontenay-aux-Roses, France). pp 806-27 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Results pertaining to the ternary system U–Pu–O are presented. The homogeneity ranges, corresponding to the various phases $MO_{2\pm x}$, α-M_2O_3 and β-M_2O_3 were delineated at room temperature. The $MO_{2\pm x}$ and α-M_2O_3 phases exhibited a large homogeneity range; there was no MO compound. (auth)

32996 DEFECT EQUILIBRIA OF PuO_{2-x}, 1045°C TO 1505°C. Atlas, L. M.; Schlehman, G. J. (Argonne National Lab., Ill.). pp 838-44 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The variation of O_2 content and electrical conductivity (σ) with O_2 pressure ($p(O_2)$) was measured for PuO_{2-x} between 1045 and 1505°C. Experimental results are presented as plots of ΔG_O^0 (the relative partial molar free energy of O_2) vs log x, ΔG_O^0 vs temperature, log x vs log $p(O_2)$ and log σ vs log $p(O_2)$. The log-log plots of x and σ against $p(O_2)$ are linear over a wide composition range and at each temperature, the composition line has a steeper slope than the conductivity line. A mass-action analysis of the data suggests that the defects in PuO_{2-x} are predominantly interstitial Pu ions in either the +3 or +4 state, and that the oxide is a hopping model semiconductor. A detailed consideration of the entropy and enthalpy changes involved in creating Pu interstitials or O_2 vacancies in PuO_{2-x} permits the formulation of general relations between $p(O_2)$, x, and T. These relations give fairly accurate values of $p(O_2)$ for $PuO_{1.90}$ at 1045, 1235, 1415, and 1505°C from data measured only at 1140°C. After imposing the condition $\partial(\ln p(O_2))/\partial x = O$, the equations also predict the transformation of $PuO_{1.90}$ into a phase mixture near 630°C. (auth)

32997 ELECTRICAL RESISTIVITY AND PHASE RELATIONS FOR THE THORIUM–CARBON SYSTEM. Chiotti, P.; Korbitz, F. W.; Dooley, G. J. (Ames Lab., Iowa). Contract W-7405-eng-82. J. Nucl. Mater., 23: 55-67(July 1967). (IS-1508).

The electrical resistivity of Th–C alloys was measured for compositions of 4 to 70 at. % C and temperatures of 25 to 2400°C. The data are consistent with the existence of a miscibility gap in the Th–ThC region, a miscibility gap in the ThC–ThC_2 region and a fcc solid solution extending from pure Th to ThC_2 at high temperatures. Boundaries for the miscibility gaps are given. ThC_2 undergoes two allotropic transformations, the first at 1370 ± 15°C and the second at 1470 ± 15°C. At lower C compositions the transformation temperatures are lowered to 1260 ± 10 and 1460 ± 10°C, respectively. Isothermal resistivity–composition plots for various temperatures up to 2400°C are presented. Each curve shows a maximum, which at 25°C occurs at 48 at. % C and a specific resistivity of 196 $\mu\Omega\cdot$cm; at 2400°C it occurs at about 53.4 at. % C and 290 $\mu\Omega\cdot$cm. At 25°C the dicarbide has a resistivity of 20.0 ± 1.0 $\mu\Omega\cdot$cm. The value for the monocarbide is not well defined, the resistivity changes from 195 to 120 $\mu\Omega\cdot$cm in a composition range of about 49 to 51 at. % C. A phase diagram based on these and other data is presented. (auth)

32998 STUDY OF THE MICROGRAPHIC STRUCTURE AND THE OXIDATION BEHAVIOR OF ANY BLACK ZIRCONIA OBTAINED BY FUSION IN AN ELECTRON BOMBARDMENT OVEN. Beranger, G.; De Gelas, B.; Ono, K.; Lacombe, P. (Ecole des Mines, Paris). J. Nucl. Mater., 23: 68-74(July 1967). (In French).

White ZrO_2, on melting by electron bombardment, yields "black" ZrO_2 which is O-deficient, and contains a fine precipitate of Zr saturated with O. The fine structure of ZrO_2 prepared in this manner was studied by optical micrography, x-ray diffraction, dilatometry and electron microprobe analysis. The structure can be interpreted in terms of the Zr–O equilibrium diagram. A study of the behavior during oxidation of black ZrO_2 permitted an estimate of its deviation from stoichiometry, and revealed that the O-rich Zr particles in the ZrO_2 matrix are preferentially oxidized. This latter phenomenon is discussed in relation to the oxidation of Zr in general. (auth)

32999 CONTRIBUTION TO THE STUDY OF THE U–C–O SYSTEM. Bazin, J.; Accary, A. (CEN, Saclay, France). Proc. Brit. Ceramic Soc., No. 8, 175-91(June 1967).

The exact nature of the phases that appear in the univariant equilibrium usually written $3UC_2 + UO_2 \rightleftharpoons 4UC + 2CO$ were studied at 1720 to 2070°K. The phases were determined by x-ray diffraction. The UC phase contains from 200 ± 200 ppM O at 1720 to 600 ± 200 ppM at 2070°K. The UO_2 phase proved to be stoichiometric, in contrast to the values for the lattice parameter of UO_2 available in the literature. From considerations of lattice parameters and thermodynamics, under equilibrium conditions the UC_2 phase contains dissolved O. The above equation should therefore be replaced by: $(3-2x)\,U[C_{2(1-y)}, O_y] + (1-3y+2x)\,UO_2 \rightleftharpoons (4-3y)\,U(C_{1-x}, O_x) + (2-3y+xy)\,CO$. (auth) (UK)

33000 THERMODYNAMICS OF NON-STOICHEIOMETRIC OXIDE SYSTEMS. Roberts, L. E. J.; Markin, T. L. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceramic Soc., No. 8, 201-17(June 1967).

Oxide systems based on the fluorite structure exhibit wide ranges of nonstoichiometry at high temperatures; the disorder mainly affects the anion sublattice, with the introduction of interstitial O or of O vacancies. The defects order at low temperatures to give complex superstructures. Structural evidence suggests that domains having a local structural configuration similar to that of the next ordered phase persist in the nonstoichiometric ranges, though long-range order is destroyed. The thermodynamic data are shown to be compatible with this view and to provide some further direct support. Thermodynamic data for solid solutions such as $(U,Th)O_{2+x}$ and $(U,Pu)O_{2-x}$ are compared with data for the binary systems UO_{2+x} and PuO_{2-x}; the enthalpy values are very different when the cations of variable valence are sufficiently diluted with inert cations, so that the local configurations which can form in the binary systems can no longer occur. Rapid changes of thermodynamic properties can occur close to a stoichiometric composition when two types of defect can be formed with very different energies of formation. (auth) (UK)

33001 MISCIBILITY GAP IN THE Th–ThC SYSTEM FROM HIGH-TEMPERATURE X-RAY DATA. Chiotti, P.; White, R. W. (Ames Lab., Iowa). Contract W-7405-eng-82. J. Nucl. Mater., 23: 37-44(July 1967). (IS-1489).

X-ray diffractometer data at 25 to 1600°C were obtained for Th and for a series of Th–C alloys containing up to 4.92 wt % C. All of these alloys were found to be single phase at 1600°C. The critical temperature and composition for the miscibility gap are 1570 ± 25°C and 2.2 wt % (30.0 at. %) C, respectively. At 600°C the gap extends from 0.27 to 3.75 wt % (4.9 to 43.2 at. %) C. The lattice constants for these two solid solutions are 5.135 ± 0.005 and 5.317 ± 0.005 Å, respectively. The lattice constant of the fcc solid solution at the critical temperature and composition is 5.301 ± 0.005 Å. Lattice constants as a function of temperature for alpha- and beta-Th, ThC, and some of the alloys are presented. The lattice constants for ThO_2 for temperatures up to 1500°C are also presented. (auth)

33002 INVESTIGATIONS ON THE FORMATION OF NON-METAL-STABILIZED ZIRCONIUM-RICH TRANSITION METAL PHASES. Holleck, H.; Thuemmler, F. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater., 23: 88-94(July 1967). (In German).

The following metalloid-stabilized phases were found in Zr-systems with other transition metals, when nonmetallic atoms (C, N, O) are present: $Zr_4Co_2O_x$, $Zr_4Re_2O_x$, $Zr_{3.5}V_{2.5}N_x$, $Zr_4Co_2N_x$, $Zr_4Ni_2N_x$, $Zr_4Ru_2N_x$, $Zr_4Rh_2N_x$, $Zr_4Re_2N_x$, $Zr_4Os_2N_x$, $Zr_4Ir_2N_x$, and $Zr_4Pt_2N_x$ when $0 < x < 1.5$. All these compounds crystallize in partly filled Ti_2Ni-type structure. C showed a small tendency to stabilize such phases in contrast to N_2 and O_2. Only investigations on fuels with a high burnup can show if such or similar phases also occur in irradiated fuels. (auth)

33003 EFFECT OF VANADIUM OXIDE ADDITIONS ON SINTERING AND GRAIN GROWTH OF URANIUM DIOXIDE. Amato, I. (FIAT, Turin); Ravizza, M.; Colombo, R. L. J. Nucl. Mater., 23: 103-6(July 1967).

Weighed amounts of reagent-grade V_2O_5 were added to UO_2 to give compositions of 0.68, 1.38, and 2.10 wt %. The mixtures were ball-milled, dried, pressed, and sintered in dry hydrogen for 0.5 to 10 hr at 1400 to 1700°C. Vanadium oxide in UO_2 sharply reduced the grain growth rate and in some cases annulled it after a few hours.

The effect was higher, in the range examined, the higher the concentration of V_2O_5. (M.C.G.)

33004 PHASE RELATIONS IN THE ZrO_2–MgO SYSTEM. Grain, Clark F. (College Park Metallurgy Research Center, Md.). J. Amer. Ceram. Soc., 50: 288-90 (June 21, 1967).

Phase relations were studied in the system ZrO_2–MgO with emphasis on the range 1350 to 1600°C. A phase relation was determined from samples, using precision lattice parameters, x-ray diffraction line intensities, and petrographic observations, and from dynamic observations of the phases present using high-temperature x-ray diffraction techniques. Limits were established for the solubility of MgO in tetragonal ZrO_2 and for the range of the cubic solid solution. The phase relations below 1240°C were complicated by hysteresis in the monoclinic to tetragonal inversion of ZrO_2. (auth)

33005 SOME PROPERTIES OF SINTERED WC–TiC–10 PERCENT (Co + Ni) ALLOYS. Suzuki, Hisashi; Hayashi, Kozi; Kawakatu, Ichiro (Tokyo Univ.). Nippon Kinzoku Gakkaishi, 31: 160-4 (1967). (In Japanese).

WC–TiC–10% (Co + Ni) alloys having various contents of TiC and carbon and various ratios of Co/Ni were vacuum-sintered over a definite temperature range from 1400 to 1430°C and their fundamental properties studied. The alloys formed a three- or two-phase region depending on the TiC content, in a way similar to WC–TiC–Co alloys. The width of the three-phase region for a constant TiC content, however, increased slightly with increasing Ni content in the binder. Lattice parameters of the binder phase and the β phase reached constant values in the four-phase regions adjacent to the three-phase region. In the three-phase region, the former decreased and the latter increased with increasing carbon content in the alloys. The amount of dissolved tungsten in the binder phase increased with decreasing carbon content and with increasing Ni content. Titanium carbide hardly dissolved in the binder phase, as observed in WC–TiC(TaC)–Co alloys. Rupture strength of each three-phase alloy showed a maximum at the high carbon side. The alloys with high TiC contents were markedly strengthened with increasing Ni content in the binder. Magnetic saturation of the alloys decreased with increasing Ni content. In the case of pure Ni or extremely high Ni binder, the alloys with lower carbon contents transformed to be nonmagnetic. In short, the properties of WC–TiC–Co–Ni alloys can easily be understood in consideration of the properties of WC–TiC–Ni alloys. (auth)

Radiation Effects

Refer also to abstracts 32934, 32936, 32944, and 34174.

33006 (EUR-3289.e) DISLOCATION-LOOPS IN NATURAL GRAPHITE SINGLE CRYSTALS REACTOR-IRRADIATED AT 1200°C. Heerschap, M. (European Atomic Energy Community, Petten (Netherlands). Joint Nuclear Research Center). Mar. 1967. 17p. Dep.

Interstitial loops of a dia of about 1000 Å decorated with small vacancy loops of a dia of about 100 Å were observed in graphite single crystals irradiated at 1200°C and are discussed. These loops are unsheared. In graphite, single crystals irradiated at 1200°C and subsequently annealed at 2200°C separate interstitial and vacancy loops were found. The vacancy loops are all sheared. The interstitial loops are unsheared except in some cases where they are sheared, probably by the passage of a dislocation ribbon. Partial dislocations pinned by sheared interstitial loops were observed. In some instances the loops have grown preferentially along dislocations or grain-boundaries. (auth)

33007 (NUMEC-3432-30) IRRADIATION TESTING OF PuO_2–UO_2 FUELS. Quarterly Progress Report, October 1–December 31, 1966. (Nuclear Materials and Equipment Corp., Apollo, Pa.). May 1967. Contract AT(30-1)-3432. 32p. Dep. CFSTI.

Progress on the program covering irradiation of capsules containing PuO_2–UO_2 fuel elements, of compositions relevant to fast breeder reactors and to Pu recycling in thermal reactors, is reported. Metallographic structures and autoradiographs of stoichiometric substoichiometric capsule sections are shown as is microstructure of fuel–stainless steel cladding interfaces. (P.G.C.)

33008 INFLUENCE OF NEUTRON RADIATION UPON PLUTONIUM CONTAINING SOLIDS. Barnes, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). pp 914-32 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

An outline of the principal radiation effects that occur in both metallic and nonmetallic U fuels is given and from this the general behavior of Pu fuels is inferred. Effects due to the displacement of atoms are considered to be unimportant. The major effects at high burnup arise from the fission products and the behavior of the inert gases and other fission products that are either soluble, insoluble, or volatile are all considered. (auth)

33009 IRRADIATION BEHAVIOUR OF PLUTONIUM ALLOY FUELS FOR FAST REACTORS. Beck, W. N.; Murphy, W. F.; Kittel, J. H.; Foote, F. G. (Argonne National Lab., Ill.). pp 933-48 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Alloys containing both U and Pu are being developed for use as fuels for fast breeder reactors. The alloys selected for the study were U-Pu-Fs, U-Pu-Ti, and U-Pu-Zr. Preliminary irradiations were conducted on the U-Pu-Fs systems, which, without cladding, were found to swell catastrophically at low irradiation temperatures. Since the fuel alloy was intended to be operated at temperatures as high as 720°C it was evident that considerable reliance would have to be placed on the restraint characteristics of the jacket. Observations on the irradiation behavior of jacketed-sodium-bonded fuel pins showed that the properties of the fuel material are of secondary importance compared with the properties and dimensions of the jacket material. In addition to tests on different jacket materials, variations involving vented jackets, annular clearance between fuel and jacket, jacket thickness, and void volumes were studied. U-Pu-Fs alloy jacketed in Nb-1 wt % Zr alloy was successfully irradiated to 8.7 at. % burnup at maximum jacket surface temperatures of 545°C, thus providing a convincing demonstration of the effectiveness of jacket restraint for control of swelling. U-Pu-Ti and U-Pu-Zr alloys, which have higher melting points than U-Pu-Fs alloys, are presently being irradiated at jacket surface temperatures of 560 and 600°C, respectively. They have achieved burnups without failure to date of 4.6 and 4.2 at. %, respectively. Equations were derived, which establish the relationship of jacket rupture with burnup temperature, jacket dimensions, and mechanical properties. Irradiation tests are being conducted with specimens designed to verify the predicted relationships. Preliminary results indicate that the calculations are conservative and that burnups can be achieved that substantially exceed the calculated values. (auth)

33010 IRRADIATION BEHAVIOUR OF PLUTONIUM–URANIUM MONOCARBIDE. Bradbury, B. T.; Frost, B. R. T.; Findlay, J. R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 949-78 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Work carried out at Harwell to study the behavior of $(U_{0.85}Pu_{0.15})C$ under irradiation is reported. Two of the principal variables in these experiments were the method of fabrication (arc-melting and sintering) and the carbon content. Brief descriptions are given of the methods used. Miniature fuel elements, sealed stainless-steel tubes containing fuel, were irradiated in DIDO at Harwell and in the Dounreay Fast Reactor to burnups of up to 8% (U + Pu) atoms. The swelling behavior of the fuel, the migration of fission products (particularly Xe and Kr) and the thermal conductivity of the fuel were studied as a function of composition and irradiation exposure. These experiments were supported by more fundamental studies of the kinetics and mechanisms of fission gas movement and release in this fuel. (auth)

33011 IRRADIATION BEHAVIOUR OF SOLID SOLUTION URANIUM–PLUTONIUM MONOCARBIDES AT HIGH BURNUPS. Strasser, A. (United Nuclear Corp., White Plains, N. Y.); Cihi, J.; Hurwitz, S.; Martin, R. pp 979-1003 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The results of irradiation tests of solid solution (UPu)C up to high burnups [38×10^{20} fiss/cc (113,000)MWD/T], are presented. Four clad specimens of $(U_{0.8}Pu_{0.2})C$ were irradiated at average power levels of 490 to 265 W/g of fuel. The experiment design, specimen fabrication, irradiation test conditions, and post-irradiation examination are described. The two Nb-clad specimens were sound and in excellent condition after irradiation. The cladding of the two stainless steel clad specimens was ruptured as a result of a drastic decrease in the ductility of the steel to a level below that required to accommodate strains from fuel expansion and thermal stresses. Thirty per cent of the fission gases indicated by theory were released during irradiation. The structural and dimensional stability of the fuel was excellent: 0.5 to 0.6% OD increase per at. % burnup. The microstructure of the fuel was es-

sentially unchanged. No significant difference was found between fuels prepared with or without a Ni sintering aid. (auth)

33012 RECENT POST-IRRADIATION OBSERVATIONS ON MIXED CARBIDE SPECIMENS. Frost, B. R. T.; Bradbury, B. T. (Atomic Energy Research Establishment, Harwell, Eng.). pp 1004-5 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Some post-irradiation observations of mixed carbide type fuels for fast reactors are reported. Detailed calculations of thermal stresses in the Nimonic 90 cladding indicate that the 100-hr rupture stress was exceeded and led to the belief that observed failures were probably due to combination of thermal stress and fuel swelling. Results of optical metallography studies, dimensional measurements, and radiographic studies on irradiated samples are described. The preferred fuel type is stoichiometric or slightly C-rich sintered carbide; and at temperatures of 850° to 900°C, the fission-gas release is generally <3% and up to 10% burnup. (B.L.M.)

33013 IRRADIATION TESTS ON MIXED UC–PuC. Mustelier, J. P. (CEN, Fontenay-aux-Roses, France). pp 1006-8 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Irradiation test results on 3 specimens consisting of sintered mixed (UPu)C irradiated at 19,000 MWd/te in a thermal flux containing 8.45% PuC are reported. The pellets were clad in 316L stainless steel. The specimen characteristics and test results are tabulated. The maximum value observed for swelling of the carbides was 4%. (B.L.M.)

33014 IRRADIATION PROPERTIES OF HIGH ENERGY RATE PNEUMATICALLY-IMPACTED UO_2–PuO FUELS. Skavdahl, R. E.; Freshley, M. D.; Bailey, W. J.; Goldsmith, S. (Battelle-Northwest, Richland, Wash.). pp 1013-42 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc.. 1967.

See CONF-651102.

Irradiation performance of test capsules and PRTR fuel elements containing pneumatically impacted UO_2-PuO_2 fuel material demonstrated that mixed oxides prepared by this process are comparable with or better than ceramic fuels prepared by other processes. The satisfactory performance was demonstrated for maximum rod powers of 1160 W/cm (35 kW/ft) and to burnups as high as 6.8×10^{20} fissions/cc (27,500 MWd/te fuel). Structures formed during irradiation of pneumatically impacted UO_2-PuO_2 are similar to those formed during the irradiation of UO_2. Homogenization of the mechanically mixed UO_2-PuO_2 occurs at fuel temperatures sufficient to cause in-reactor sintering and grain growth. Fission products migrate to preferred locations at the higher operating temperatures. Fission product Zr-^{95}Nb, ^{90}Sr, and Ce-^{144}Pr migrate the least, whereas ^{137}Cs and ^{106}Ru migrate the most. Alpha autoradiographs indicate that, under certain conditions, alpha-emitters (possibly Pu) segregate from the liquid in high-performance UO_2-PuO_2 fuels. This has not yet been substantiated by chemical analysis. There is good agreement between the fission gas release characteristics of capsules and full-sized PRTR elements. The fission gas release values rapidly approach 100% for volumetric average fuel temperatures near 2000°C. (auth)

33015 IRRADIATION TESTING OF UO_2–PuO_2 FUELS. Ross, W. J.; Puechl, K. H.; Caldwell, C. S.; Shipko, F. J.; Miles, J. F. (Nuclear Materials and Equipment Corp., Apollo, Pa.). pp 1043-62 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

The behavior of UO_2-PuO_2 fuels under irradiation is being studied to determine the influence of process variables and physical and chemical properties. For this purpose, five instrumented capsules, each containing five UO_2-PuO_2 fuel elements, was fabricated, and these capsules are being irradiated in the General Electrical Testing Reactor. Two capsules contain a fuel composition, UO_2-5% PuO_2, suitable for plutonium recycle in thermal converter reactors and three capsules contain a composition, UO_2-20% PuO_2, suitable as a fast breeder fuel. The two low enrichment specimens are identical. One has been irradiated to approximately 10,000 MWd/t, the other to 20,000 MWd/t. The results of post-irradiation examination of these specimens is reported. The fast reactor compositions are being irradiated for longer periods of time, up to 100,000 MWd/t, and hence these elements are still in-pile. (auth)

33016 FISSION GAS RELEASE FROM MIXED OXIDE FUELS. Bagley, K. Q.; Donaldson, D. M. (Dounreay Experimental Reactor Establishment, Thurso, Scotland). pp 1063-86 of Plutonium 1965. Proceedings of the Third International Conference on Plutonium, London, November 22–26, 1965. Kay, A. E.; Waldron, M. B. (eds.). New York, Barnes and Noble, Inc., 1967.

See CONF-651102.

Studies of the fission gas release from mixed oxide, (U, 15% Pu)O_2, fuels irradiated to high burnup at heat ratings of ~200 W/g and maximum fuel temperatures in excess of 1500°C are being carried out as part of a general examination of the irradiation behavior of potential fast reactor fuels. Fuel pins containing 2 to 36 in. of fuel in the form of 0.2 in. diameter high-density solid or annular pellets or vibro-compacted powders of ~80% theoretical density were irradiated in either a fast or thermal reactor to burnups in the range 0.1 to 6.0% of heavy atoms. Fission gas release values greater than 25% were observed in all fuel types at burnups beyond 1%. Vibro-compacted fuel pins irradiated under comparable conditions showed an almost linear dependence of gas release fraction on burnup, and a tendency was evident for the quantity of gas retained in this fuel to reach a maximum value at about 3% burnup. (auth)

33017 RADIATION-INDUCED DEFECTS AND STRUCTURE OF BARIUM SILICATE GLASSES. Bishay, A. M.; Gomaa, Ibrahim (Atomic Energy Establishment, Cairo. American Univ., Cairo). J. Amer. Ceram. Soc., 50: 302-7(June 21, 1967).

The effect of increasing BaO on the intensity and position of absorption bands induced in barium silicate glasses was studied. Many of these glasses showed a two-step process in the growth and thermal bleaching curves. This process was attributed to two types of defects in the glass, induced and intrinsic. Infrared absorption, molar volume, and x-ray diffraction studies predicted structural changes at compositions containing about 22.5 and 27.5 mole % BaO. The results of gamma-induced absorption were in line with these predictions, supporting the view that color center studies can be used to detect changes in structure, especially when high radiation doses are applied. (auth)

33018 ENHANCED NEUTRON RADIATION DAMAGE AT TWIN BOUNDARIES. Brimhall, J. L.; Mastel, B. (Pacific-Northwest Labs., Richland, Wash.). J. Appl. Phys., 38: 3027-8 (June 1967).

The increased concentration of defect clusters at coherent twin boundaries was presented as evidence for the existence of focusing and channeling events in neutron-irradiated nickel. The denuding of the clusters at incoherent twin boundaries indicates that point defects can be readily conducted away at the incoherent boundaries. (M.O.W.)

33019 EFFECTS OF NUCLEAR RADIATION ON ELECTRICAL PROPERTIES OF NON-STOICHIOMETRIC NICKEL OXIDE. Nachman, Manfred; Cojocaru, Leu; Ribco, Lidia (Inst. for Atomic Physics, Bucharest). Nukleonik, 10: 1-2 (June 1967).

The effects of fast neutrons on the electrical conductivity and Seebeck coefficient of sintered Ni-oxide pellets with various contents of excess O_2 was investigated. It was established that exposure to an integral fast neutron flux of 4×10^{17} nvt, of samples with higher excess-O_2 content (0.2×10^{-4} O atoms per NiO molecule) leads to a decrease in their electrical conductivity and Seebeck coefficient. It seems that the observed effects may be attributed to radiation-induced defects in the lattice. (auth)

33020 F CENTERS IN THORIUM OXIDE. Neeley, V. I. (Battelle-Northwest, Richland, Wash.); Gruber, J. B.; Gray, W. J. Phys. Rev., 158: 809-13(June 15, 1967).

Single crystals of ThO_2 grown in our laboratory have been subjected to ionizing radiations of 2-MeV electrons, ^{60}Co γ rays, and 150-keV x-rays. The electron-spin-resonance spectrum of these irradiated single crystals indicates that an electron is trapped near an O^{2-} vacancy in the crystal lattice of ThO_2. The ESR spectrum is the same regardless of which radiation was used to bombard the samples. Optical and ESR low-temperature studies have demonstrated that no paramagnetic ion impurities are present in the samples prior to irradiation, and similar studies performed on irradiated samples indicate that the observed signal is not the result of valence changes produced by irradiation of ions in the crystal. The observed spectrum can be interpreted as due to a defect having local tetrahedral symmetry which is very slightly distorted axially along the body diagonal in the over-all cubic symmetry of the ThO_2 lattice. Room-temperature g values are $g_{\parallel} = 1.9739$ and $g_{\perp} = 1.9644$. The linewidth at half-maximf ranges from approximately 32 G at room temperature to less than 1.5 G near liquid

helium temperature. All evidence so far examined leads us to conclude that we have observed the ThO_2 F center. (auth)

Plastics and Other Materials

Refer also to abstracts 32936 and 32944.

33021 MEASUREMENT OF MICROWAVE DIELECTRIC CONSTANT OF GAMMA-IRRADIATED ROCHELLE SALT. Asch, Georges; Michel, Robert (Univ., Lyon). Jap. J. Appl. Phys., 6: 1008(Aug. 1967).

The microwave dielectric constant was measured for Rochelle salt and gamma irradiated Rochelle salt as a function of temperature. (M.O.W.)

33022 THE THERMAL CONDUCTIVITY OF ZTA GRAPHITE. Wagner, P.; Dauelsberg, L. B. (Los Alamos Scientific Lab., N. Mex.). Carbon, 5: 271-9(June 1967).

Measurements of the thermal conductivity of ZTA graphite from −100°C to 2700°C are reported. Three different methods were used: a transient technique, a series comparison method, and a radial heat flow method. From room temperature to 2700°C, the thermal conductivity perpendicular to the applied fabrication force (i.e., parallel to the grain) is given by $k = 460/T(°K) + 0.28 W/cm°K$. In the direction parallel to the applied force the thermal conductivity results are more difficult to interpret, since use of the radial heat flow method introduced a two-dimensional heat flow problem with nonlinear boundary conditions. An inherent variation in the measured values of the thermal conductivity also had to be considered. These problems are discussed. The results as a whole are discussed in terms of some current ideas on heat conduction in single crystal graphite. Measurements of thermal expansion and dimensional changes which occur during the course of these measurements are described and analyzed. (auth)

33023 THE EFFECT OF DEFECTS ON THE BASAL PLANE THERMAL CONDUCTIVITY OF A GRAPHITE CRYSTAL. Kelly, B. T. (United Kingdom Atomic Energy Authority, Lancs, Eng.). Carbon, 5: 247-60(June 1967).

The theory of the principal thermal conductivities of a graphite crystal is considered in the relaxation time approximation using theoretical treatments of the lattice vibration spectrum. The results are applied to the calculation of the effect of grain boundaries on the basal plane conductivity of a graphite crystal. The effect of point defects and isotopes is treated using the harmonic mean free path for phonon scattering. In each case an approximation to the graphite lattice in which the layer planes are uncoupled is assumed. It is shown that the effect of point defects and isotopes on the "out-of plane" vibrations of the graphite lattice is similar to that on the "in-plane" vibrations. The theoretical results are applied to experimental measurements of the conductivity of pyrolytic graphite of varying perfection and also to measurements of the change of thermal conductivity of graphite under fast neutron irradiation. The theory of point defect scattering is found to give good agreement with the changes in conductivity introduced by fast neutron irradiation and also with the temperature dependence of the thermal conductivity of irradiated graphite. The well known relationship between stored energy and fractional change in thermal resistance is explained. The theory yields values of mean free path L_a for grain boundary scattering in reasonable agreement with those obtained from electrical resistance measurements. (auth)

PHYSICS (GENERAL)

Astrophysics

Refer also to abstracts 33125, 33179, 33181, 33184, 33223, 33668, and 33676.

33024 (AD-642106) NEW DETERMINATIONS OF THE FARADAY ROTATION FOR EXTRAGALACTIC RADIO SOURCES. Report No. 9. Berge, G. L.; Seielstad, G. A. (Owens Valley Radio Observatory, Pasadena, Calif.). 1966. Contract Nonr-220(19). 16p. CFSTI.

Data are presented on the linear polarization properties of 42 radio sources at 18.0-cm wavelength. These are combined with data obtained previously at other wavelengths to obtain rotation measures. The dependence of all reliable rotation measures on the galactic coordinates is interpreted in terms of the magnetic field within the local spiral arm. (auth) (TAB)

33025 (AD-642165) MEASUREMENTS OF THE FLUX DENSITIES, POSITIONS, AND ANGULAR WIDTHS OF PLANETARY NEBULAE AT 10 AND 21 CM WAVELENGTHS. Report No. 8. Thompson, A. R.; Colvin, R. S.; Stanley, G. J. (Owens Valley Radio Observatory, Pasadena, Calif.). 1966. Contract Nonr-220(19). 20p. CFSTI.

Observations of 36 planetary and two diffuse nebulae were made using the two 90-ft-diameter antennas. The effects of confusion with non-thermal radio sources were examined statistically. In addition some indication of the nebulae for which confusion is most serious was obtained from a comparison of the radio positions with optical positions. Errors in the flux density measurements resulting from confusion should be small at 10 cm but are more serious at 21 cm. Angular widths of 29 of the nebulae were measured at 10 cm using spacings of 2351 and 4701 wavelengths east–west. The radio widths are in agreement with optical widths for approximately 80% of the nebulae, and in the remaining cases it appears probable that the discrepancies are an indication of confusion or of uncertainties in the optical data rather than nonthermal emission. The ratios of the measured radio and H beta flux densities of the nebulae show general agreement with the theoretical ratio for thermal emission, and discrepancies result most probably from errors in the estimated H beta absorption. (auth) (TAB)

33026 (AD-642166) THE RADIO SOURCE 3C-17. Report No. 10. Moffet, A. T.; Schmidt, M.; Slater, C. H.; Thompson, A. R. (Owens Valley Radio Observatory, Pasadena, Calif.). 1966. Contracts N00014-67-A-0094-0008; N62558-3624. 8p. CFSTI.

The position of the radio source 3C 17 is derived from 9 occultation events recorded at three observatories. The positional accuracy is about 0.5 second, and a 19th magnitude galaxy is found within 1 second of the radio position. Occultation and interferometric measurements indicate that the source is probably of the corehalo type, with a maximum diameter of 20 to 30 seconds. The optical spectrum of the galaxy shows emission lines typical of other radio galaxies, thus confirming the identification: the red shift is 0.2201. (auth) (TAB)

33027 (N-66-23752) HIGH-ENERGY X RAYS FROM THE CRAB NEBULA. Haymes, R. C.; Craddock, W. L. Jr. (Rice Univ., Houston, Tex. Dept. of Space Science). Feb. 8, 1966. 17p. (NASA-CR-74317). CFSTI.

A balloon measurement was made of the x-ray spectrum at photon energies up to 90 keV of the Crab Nebula. The instrumentation and procedures used are described. The results obtained are discussed, illustrated graphically, and compared with those of other investigators. (STAR)

33028 (N-66-37562) MASS-LUMINOSITY RELATION FOR GALAXIES. Huang, Su-shu (Dearborn Observatory, Evanston, Ill.). [1965]. 8p. (NASA-CR-78384). CFSTI.

The mass-luminosity relation for spiral and irregular galaxies found by Pskovskii and a similar relation between the mass of neutral hydrogen and the luminosity noted here lead to a relation between the total mass and the mass of neutral hydrogen for these galaxies. Several hypotheses are advanced in order to understand this relation. (STAR)

33029 (NP-16849) THE LIFETIME OF Halpha-STRUCTURES IN ACTIVE REGIONS ON THE SUN. Report No. 21. Gimse, Odd (Oslo Univ. (Norway). Institutt for Teoretisk Astrofysikk). Dec. 1, 1966. Contract AF 61(052)-743. 19p.

Time series of exposures of active regions on the sun were obtained at the Solar Observatory, Harestua, with a Zeiss Coudé refractor (D = 15 cm) and a Lyot monochromator with a passband halfwidth of 0.65 Å. By a graphic method the mean lifetime of 574 fibrills on 81 selected negatives was determined to be 4 hours. This value may be as much as 20% too high, as shown by a discussion of the uncertainties of the method. (auth)

33030 (NP-16850) ISOPHOTOMETRICAL STUDY OF WIGGLES IN THE SOLAR IRON LINES. Report No. 20. Haugen, Einar (Oslo Univ. (Norway). Institutt for Teoretisk Astrofysikk). 1967. Contract AF 61(052)-743. 37p.

Marked asymmetries are observed in the profiles of moderately strong and weak iron lines near the center of the solar disk. These asymmetries are shown to vary strongly from point to point on the sun. The properties of the asymmetries are discussed. The observations show that large-scale irregularities of the order of 10^5 km may be present in the solar photosphere. Comparison of simultaneous observation of lines of different intensity indicates that the lines are shifted relative to each others, in the sense that the stronger lines are shifted more to the red than the weaker ones. This difference between weak and moderately strong lines have been found in spectra obtained at two different observatories. If the difference in line shift between different lines is interpreted as Doppler shift, velocities up to 1 km/sec are found. (auth)

33031 (NASA-TT-F-457) THEORY OF STELLAR SPECTRA. Sobolev, V. V. Translation of Teoriya Zvezdnykh Spektrov. Izdatel'stvo, Nauka, Moscow, 1966. 286p. CFSTI.

Atomic processes associated with the formation of spectra, with special emphasis on calculation of the energy levels of the atom and the probability of transitions between these levels, are discussed. The theory of radiative transfer is next discussed. The most essential problems in the formation of spectra of different types of stars and nebulae are described. (M.O.W.)

33032 GRAPHITE AS INTERSTELLAR MATTER. Borg, K. (Lund Observatory, Sweden). Nature (London), 215: 145-6(July 8, 1967).

Since graphite consists of hexagonal crystals the optical constants depend on the direction of the incident light. For light with an electric vector parallel to the basal planes of the crystals, graphite behaves like a metal. In the perpendicular direction, for light propagation through a crystal with an electric vector along the optic axis, the material behaves like a dielectric particle. In most calculations on graphite as interstellar matter the electric vector has been treated as in the basal plane. Lenham and Trehetne, however, measured the optical constants for graphite with the electric vector along the optic axis. Their results are shown graphically. It is concluded that no other material with similar extinction characteristics has been reported which could comprise interstellar grains. If interstellar matter consists of graphite grains, probably all the particles do not have the same orientation, which implies that some behave like dielectric particles and some like metals. Depressions in observed extinction curves could be caused by graphite grains behaving like dielectric particles. Assuming, however, particles orientated at random, such particles will give a resulting extinction with a shallow depression, since "metallic" graphite shows no depression and the resulting extinction is an average value. This would give better agreement with reported observations. It is noted that combinations of ice and graphite would probably also given an agreeing depression. (UK)

33033 QUANTUM COSMOLOGY. Harrison, E. R. (Univ. of Massachusetts, Amherst). Nature (London), 215: 151-2(July 8, 1967).

A continuous fluid is used to represent the complex contents of the universe in cosmology. Homogeneous and isotropic models show that the universe originated from a space–time singularity of infinite density 10^{10} years ago. Before accepting singularities of infinite density the question arises as to whether the continuous fluid models are realistic representations of an early dense universe, and given that an infinite density is possible in a continuous fluid, does it follow that an infinite density is possible in a fluid consisting of particles. These questions are discussed. (UK)

33034 SUN'S MAGNETISM. Livingston, William C. (Kitt Peak National Observatory, Tucson, Ariz.). Sci. J., 3: No. 6, 46-53(June 1967).

Various theories put forward to explain how these sources of magnetic fields evolve on the Sun's surface and then disperse outwards into the solar system are discussed. Newly developed astronomical techniques have revealed details of the origin of the Sun's magnetic fields and the effects they produce as far into space as the edge of the Earth's magnetic field. (auth) (UK)

33035 SOLAR RADIATION AT 19.0 Gc/s DURING THE ECLIPSE OF MAY 20, 1966. Croom, D. L.; Powell, R. J. (Ra-

dio and Space Research Station, Slough, Eng.). Nature (London), 215: 260-1(July 15, 1967).

Observations of solar radiation at 1.58-cm wavelength are reported and analyzed. These were made at a site near Athens during the annular eclipse of the Sun on the above date. Solar and atmospheric conditions at the time are described. Evidence was obtained for the existence of a source of enhanced radiation extending to at least 11,000 km beyond the east limb. The intensity of this source appeared to be about 1.3% of the total solar flux. (UK)

33036 ROLE OF IMPURITIES IN INTERSTELLAR GRAPHITE GRAINS. Ireland, J. G.; Nandy, K.; Seddon, H.; Wolstencroft, R. D. (Royal Observatory, Edinburgh). Nature (London), 215: 377-8(July 22, 1967).

Accurate measurements of the wavelength dependence of interstellar obscuration in the spectral range 10,000 to 3,400 Å show a distinct change in the slope of the extinction curve at 4,300 Å. The magnitude of this change varies significantly from one region to another. Evidence is presented that the "knee" of the extinction curve at 4,300 Å may be due to graphite particles containing small amounts of impurities. This evidence is deduced from studies on the wavelength dependence of absorption coefficients and refractive indexes of various grades of coals, anthracites, and natural and artificial graphites. An interesting feature of the absorption coefficient/wavelength curve for a high quality coal was that a change in slope occurred near 4,200 Å, close to the wavelength of the "knee" of the interstellar extinction curve. A similar change in slope appeared at 4,300 Å for a semi-anthracite. Ways in which impurity atoms can be incorporated into the graphite grain structure are discussed. The most likely impurities causing these effects are hydrogen and oxygen. (UK)

33037 NUCLEOSYNTHESIS IN SUPERNOVA SHOCK WAVES. Truran, J. W.; Arnett, W. D.; Cameron, A. G. W. (Goddard Space Flight Center, New York). Can. J. Phys., 45: 2315-32 (July 1967).

It is generally assumed that element synthesis will take place readily under the extreme conditions believed to exist in supernova explosions. The types of thermonuclear reactions that can occur in a supernova shock wave which propagates through the stellar envelope, in which a temperature $\sim 5 \times 10^9$°K may occur for $\sim 10^{-2}$ seconds, were examined. The calculations were performed using a network of nuclei connected to their neighbors by absorption or emission of neutrons, protons, alpha particles, and photons (Truran et al. 1966). The results show that iron-peak elements can be produced by a supernova shock wave, but the iron-peak composition observed in nature is not produced unless some transformation of protons to neutrons has taken place in the material before the passage of the shock wave. Furthermore, a neutron flux sufficient to drive the rapid neutron-capture process is not attained under these conditions in the stellar envelope. (auth)

33038 THERMAL INSTABILITY IN NONDEGENERATE STARS. Ziolkowski, Janusz. Postepy Astron., 14: 265-74 (Dec. 1966). (In Polish).

A new type of thermal instability, existing in a nondegenerate shell containing a highly temperature-sensitive nuclear-energy source, is described. The existence of the instability is explained by a physical analysis and by a mathematical derivation. (auth)

33039 ASYMMETRY OF THE SUNSPOTS IN THE HELIOGRAPHIC LONGITUDE. Szymanski, Waclaw. Postepy Astron., 14: 249-55(Dec. 1966). (In Polish).

Asymmetry of the sunspots in the heliographic longitude results from simultaneous action of three factors: rotation of the Sun, increasing of the area of spots, and the sphericity of the Sun causing perspective decreasing of spot area depending on their distance from the central meridian. Asymmetry of spots results only from geometrical conditions of observation on the sunspots. (auth)

33040 NONRADIAL PROBLEMS IN THEORY OF THE STELLAR STRUCTURE. I. Dziembowski, Wojciech. Postepy Astron., 15: 53-62(June 1967). (In Polish).

A discussion is given of the influence of rotation on the structure of the star. Particular attention is paid to the nonexistence of the thermal equilibrium when an arbitrarily assumed distribution of the angular velocity inside the star is considered; in particular the case of a rigid rotation is considered. (auth)

33041 VIBRATIONAL STABILITY OF MASSIVE STARS UNDERGOING NONRADIAL OSCILLATIONS. Sun, Wan Fook (Australian National Univ., Canberra). Bull. Cl. Sci., Acad. Roy. Belg. (5), 52: 1559-70(1966).

The vibrational stability of massive stars under nonradial oscillations was investigated and some of the results obtained for four stars of masses given by $M = M_\odot/\mu^2$ m where m = 10, 80, 250 and 400 are listed. (auth)

33042 MASSLESS PARTICLES IN VOLKOFF SPHERES. Kuchowicz, B. (Univ. of Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 289-92(1967).

In [1] (Bull. Acad. Polon. Sci., Sér. Sci. Math. Astronom. Phys., 14: 255-7(1966)) the explicit equation of the trajectory of a massless particle in the interior of a superdense star was given. The gravitational field assumed inside the star is the Schwarzschild internal solution, corresponding to the assumption of a sphere of incompressible fluid, with a constant proper mass density. The main result of [1] is that the trajectories are really contained in the fluid sphere, provided some conditions are fulfilled. The results obtained in [1] and (Acta Astronomica, 15: 297(1965)) have been generalized further to trajectories extending partially outside the fluid sphere, and to particles with a nonvanishing rest mass. In the present paper the gravitational field involved is generalized. (W.D.M.)

33043 CLUSTERING OF RADIO SOURCES. Payne, A. D. (Univ. of Tasmania, Hobart, Australia). Austral. J. Phys., 20: 291-6(June 1967).

Two methods of analysis were used in an investigation of the possible anisotropic distribution of radio sources listed in the Parkes catalogues. No significant evidence was found for clustering of sources on scales of 15′ arc to 40°. (auth)

33044 OBSERVATIONS OF SHELL-TYPE GALACTIC RADIO SOURCES. Hill, E. R. (Commonwealth Scientific and Industrial Research Organization, Chippendale, New South Wales). Austral. J. Phys., 20: 297-307(June 1967).

Radio evidence for two new supernova remnants in the Southern Milky Way is presented. Some new observations of the known supernova remnant, source 1439−62, and of the Rosette nebula, a shell source but not a supernova remnant, are also presented. The problem of finding model shells to fit the radio observations is considered and it is shown that the radio emission from 1439−62 is unlikely to originate in a shell with spherical symmetry. (auth)

33045 18 CM OH-LINE RADIATION FROM NGC 6334. Gardner, F. F.; McGee, R. X.; Robinson, B. J. (Commonwealth Scientific and Industrial Research Organization, Chippendale, New South Wales). Austral. J. Phys., 20: 309-24(June 1967).

A survey of the OH-line radiation from the region of NGC 6334 has been made with the Parkes 210-ft telescope (beamwidth 12′·2 arc, bandwidth 10 kHz). Observations of both circular and linear polarization were made at 1665 MHz, and less completely at 1667 MHz. Two centers of OH-line emission, A and B, are clearly distinguished, one on either side of the nebulosity. Each center may consist of three or more neighboring regions with radial velocities in the range −6 to −12.5 km/sec. OH-line absorption observed at radial velocities of −4.5 and +5.5 km/sec probably takes place in gas complexes between the nebula and the Sun. Strong circular polarization is present, especially in A, the more northern source, but the polarization characteristics of the two main centers are markedly different. Linear polarization is less than 10% for A. There is no clear evidence for secular variation of the line intensities. (auth)

33046 EVIDENCE FOR THE FORMATION OF AN IRON METEORITE AT 3.8×10^9 YEARS. Burnett, D. S.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett., 2: 137-47(May 1967).

Rubidium−strontium isotopic analyses were made on silicate inclusions from Kodaikanal, a brecciated fine octahedrite. Twelve analyses of different mineral fractions and separate inclusions were made. The silicates in this iron meteorite are highly enriched in alkalis and show $^{87}Sr/^{86}Sr$ ratios ranging up to 8.8. The samples lie on a well defined isochron on the Sr−Rb evolution diagram and indicate an age of $3.8 \pm 0.1 \times 10^9$ y and an initial $^{87}Sr/^{86}Sr$ ratio between 0.69 and 0.73. These data provide unambiguous evidence for the "formation" of younger solid objects in the solar system in a process which demands extensive chemical differentiation. This is evidence for an intermediate history for some meteoritic objects of a different sort than have been previously observed. (auth)

33047 ON THE SMALL-SCALE DISTRIBUTION AT 3.4-MM WAVELENGTH OF THE REPORTED 3°K BACKGROUND RADIATION. Epstein, Eugene E. (Aerospace Corp., El Segundo, Calif.). Astrophys. J., 148: L157-9(June 1967).

The angular distribution of the reported 3°K microwave background radiation is of considerable theoretical interest. As a by product of 3.4-mm observing programs some "upper-limit" statements are made about the background radiation and its small-scale angular distribution. A dual-beam observing procedure has been used with a polar-mounted 15-foot antenna that measures the antenna temperature difference between two east−west polarized antenna beams (of 3′ beam width) separated by 12′.5 in right ascension. (W.D.M.)

33048 ULTRASHORT-PERIOD STELLAR OSCILLATIONS. I. RESULTS FROM WHITE DWARFS, OLD NOVAE, CENTRAL STARS OF PLANETARY NEBULAE, 3C 273, AND SCORPIUS XR-1. Lawrence, George M.; Ostriker, Jeremiah P.; Hesser, James E. (Princeton Univ. Observatory, N. J.). Astrophys. J., 148: L161-3(June 1967).

Power spectra which are most reliable for Fourier components in the 2- to ~300-sec range were measured for a number of stellar objects. Null results are presented for six white dwarfs and a magnetic star. Nova T Corona Borealis was found to have periodic fluctuations in the 100-second range. Preliminary results for 3C 273 and Scorpius XR-1 are briefly discussed. (auth)

33049 CONDENSATION OF PRIMORDIAL DUST. Blander, M.; Katz, J. L. (North American Aviation Science Center, Thousand Oaks, Calif.). Geochim. Cosmochim. Acta, 31: 1025-34(June 1967).

Calculations of the condensation path of a gas of solar composition were made taking into account barriers to the homogeneous nucleation of the condensed phase. Results indicate that the primordial dust had much more variability to form and composition than has been previously assumed. A mechanism is deduced for the formation of meteoritic chondrules at temperatures and pressures which are much lower and more plausible than those postulated by Wood. The supersaturation of the gas phase also leads to much higher concentrations of FeO in the silicate condensate than have been calculated assuming equilibrium condensation, with the concentration of FeO in the condensate being a variable which is dependent on the conditions of condensation. This is consistent with observations of variability of the composition of FeO between different classes of meteorites and between different silicate crystallites in the unequilibrated chondrites. The possibility is raised that some of the properties of meteorites have been ascribed to a complex sequence of processes are in reality of a much simpler and more primitive origin associated with the primary condensation. (auth) (UK)

33050 RADIO EMISSION FROM THE NUCLEUS OF THE ANDROMEDA NEBULA. Pooley, G. G.; Kenderdine, S. (Cavendish Lab., Cambridge Univ., Eng.). Nature, 214: 1190-2(June 17, 1967).

Observations of the Andromeda Nebula (M 31) have been made with the Cambridge one-mile radio telescope at frequencies of 408 and 1,407 Mc. Some results on the nucleus of M 31 are described, which show that there is no source therein comparable with the Sagittarius A source in our own Galaxy, and that emission from the remnant of the supernova of 1885 is surprisingly weak. In addition, new limits were set to the radio emission from the companion galaxies M 32 and NGC 205. (UK)

33051 OPTICAL VARIATIONS IN 3C 446. Burbidge, G. (Univ. of California, San Diego). Nature, 214: 1213(June 17, 1967).

Comments are presented on the reported observations of rapid optical fluctuations of 3C 446. These variations lead to the conclusion that the region giving rise to the fluctuation is very small. Such limitations lead to very restrictive conditions on possible models of quasars, arising largely from the high radiation density that must be present in the continuum source. The lower limits to the energy densities are in the range 10 to 10^5 ergs/cm^3 if the objects are at cosmological distances, or 10^{-3} to 10 ergs/cm^3 if they lie at distances ~10 megaparsec. If the objects are at cosmological distances the radiation field is so intense that it would be self-destructive, whether arising by the synchrotron process or from the inverse Compton process. If the objects are much closer, the radiation density is reduced and problems are less severe. It has been argued that the small central continuum source is radiating at a constant rate, but is obscured periodically by absorbing clouds moving at velocities of a few thousand km/sec., but gravitationally bound to the system. This means, however, that the energy density which must be contained in the central object is even higher than that causing difficulties in previous models, reaching the value of 2×10^7 ergs/cm^3. It is concluded that such a model must be rejected, unless the objects are in or just outside the Galaxy. Evidence has recently been given which strongly suggests that the red shifts of quasars are intrinsic, and that the objects are not at cosmological distances. Even so, size considerations lead to radiation densities $\geq 10^3$ ergs/cm^3. (UK)

33052 LIMB-DARKENING OBSERVATIONS FROM 1800 TO 2800 A. Bonnet, R. M.; Blamont, J. E.; Gildwarg, P. (CNRS, Verrieres-le-Buisson, France). Astrophys. J., 148: L115-18 (June 1967).

A rocket equipped with a biaxial solar pointing system and a stigmatic spectrograph was launched on Jan. 13, 1967, from Hammaguir, Algeria, to measure the solar limb-darkening in the range 1800 to 2800 Å, especially in the neighborhood of 2076 Å, where the strong discontinuity already found by MacAllister (1960) and Tonsey (1963) seemed to be responsible for conspicuous change in the solar structure. The instrumentation is described and results from thirty-one spectra are given. (W.D.M.)

33053 AN X-RAY SURVEY OF THE CYGNUS REGION. Giacconi, R.; Gorenstein, P.; Gursky, H.; Waters, J. R. (American Science and Engineering, Inc., Cambridge, Mass.). Astrophys. J., 148: L119-27(June 1967).

In order to localize and identify x-ray sources, the Cygnus region was scanned with large-area proportional counters flown on an attitude-controlled sounding rocket. Four x-ray sources were found in the region between $70° \leq l^{II} \leq 100°$, $-16° \leq b^{II} \leq +10°$ for which locations precise to about 10 arc min. were derived. Two of the sources are reported as new, although they may have been observed previously in coarser surveys. The scanned region included Cyg A. An optical search of two of the regions has revealed an object at the location of the source Cyg X-2 which is similar to Sco X-1. Another of the sources is in the Cygnus X radio region and along the Cygnus spiral arm. (W.D.M.)

33054 ON THE OPTICAL SEARCH FOR THE X-RAY SOURCES CYG X-1 AND CYG X-2. Giacconi, R. (American Science and Engineering, Inc., Cambridge, Mass.); Gorenstein, P.; Gursky, H.; Usher, P. D.; Waters, J. R.; Sandage, A.; Osmer, P.; Peach, J. V. Astrophys. J., 148: L129-32(June 1967).

In an attempt at identification, an optical search of the sky was made near the new x-ray positions of Cyg X-1 and Cyg X-2. Photographic plates were obtained in Aug. 1966 using the 48-inch Palomar Schmidt with the Haro–Luyten three-color-image technique. The plates covered an area 7° on a side and were centered on earlier reported positions. The plates were inspected and a tentative identification was made for Cyg X-2. (W.D.M.)

33055 SOLAR X-RAY SPECTRUM FROM 1.9 TO 25 A. Fritz, G.; Kreplin, R. W.; Meekins, J. F.; Unzicker, A. E.; Friedman, H. (Naval Research Lab., Washington, D. C.). Astrophys. J., 148: L133-40(June 1967).

An Aerobee rocket was launched from White Sands on Oct. 4, 1966, at 2029 U.T., to observe the solar x-ray spectrum. The rocket carried Bragg crystal spectrometers and an array of pinhole cameras. The main features of the x-ray spectrum and tentative identifications of the emission lines recorded by two crystal spectrometers, using EDDT and KAP crystals to cover the wavelength ranges 1.7 to 8.3 Å and 5 to 25 Å, are reported. Intensities were measured by Geiger counters of 0.5-cm^2 aperture. The spectrum was scanned twice, once on ascent and once on descent. (W.D.M.)

33056 UPPER LIMIT ON THE CONCENTRATION OF MOLECULAR HYDROGEN IN INTERSTELLAR SPACE. Carruthers, G. R. (Naval Research Lab., Washington, D. C.). Astrophys. J., 148: L141-2(June 1967).

An attempt to observe the Lyman bands in the absorption spectra of early-type stars using an all reflecting image converter spectrograph flown on an Aerobee rocket on March 16, 1967, is reported. Stellar spectra were obtained extending to about 1030 Å. Comparison of these spectra with spectra taken with the same instrument in the laboratory, using an absorption cell and an argon continuum light source, indicated that the number of hydrogen molecules in the line of sight to these stars is less than about 10^{19}/cm^2 ($H/H_2 \approx 10$). (W.D.M.)

33057 POSSIBLE HORIZONTAL-BRANCH STARS AT HIGH GALACTIC LATITUDES. Philip, A. G. Davis (Univ. of New Mexico, Albuquerque. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 148: L143-6(June 1967).

Ten stars are reported which fall in the same band as do the horizontal-branch stars, and thus there is a strong possibility that these new stars are also members of the horizontal-branch population. If so, they offer an excellent opportunity for more detailed study since they are much brighter than the horizontal-branch stars in the nearest globular cluster. Positions and finding charts for these interesting stars are given and it is shown how well four-color photometry seems to separate Population-I and -II stars in the range of spectral classes B8–A7. (W.D.M.)

33058 SPECTRA OF BLUE HORIZONTAL-BRANCH STARS IN THREE NORTHERN GLOBULAR CLUSTERS. Sargent, Wallace L. W. (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 148: L147-50(June 1967).

Recent observations of faint blue stars in globular clusters and in the field have shown that these objects frequently have abnormally weak He I lines for their colors. These investigations have given a preliminary indication that metal-deficient halo stars have a low He abundance as compared with nearby B stars, although it has

been suggested that this He deficiency might be confined to their surface layers. Results of observations of blue horizontal-branch stars in three globular clusters, M13, M15, and M92, are reported. These clusters are among the brightest in the northern hemisphere and cover a range in metal deficiency as judged from their integrated spectra. M92 and M15 are exceedingly metal-deficient while M13 is only moderately so. (W.D.M.)

33059 SOLAR SPIN-DOWN PROBLEM. Howard, L. N. (Massachusetts Inst. of Tech., Cambridge); Moore, D. W.; Spiegel, E. A. Nature, 214: 1297-9(June 24, 1967).

It has been suggested that if the solar interior rotates rapidly, the resultant oblateness may noticeably affect the precession of the perihelion of Mercury. It is argued in this paper that such effects would be reduced by the action of the boundary layer between the convective envelope and the interior of the Sun. The boundary layer suction causes a slow internal motion which stretches vortex lines and spins down the solar interior. (auth) (UK)

33060 ROTATION AND HEATING OF THE PLANET MERCURY. Soter, S.; Ulrichs, J. (Cornell Univ., Ithaca, N. Y.). Nature, 214: 1315-16(June 24, 1967).

Recent radar observations indicate that the rotational period of Mercury may be coupled to its orbital period in the ratio 2:3. The study described examines the insolation and surface temperatures that would result from such coupling, and considers some observable consequences. If it is assumed that the spin–orbit ratio is 2:3, and that the axes of rotation and revolution are parallel, the diurnal period for any point is twice the orbital period, that is, 176 days. It follows that a given point on the equator is always subsolar at a specified position in the orbit. Because the orbit has a sizable eccentricity, this results in a different total energy flux falling at each point on the equator. The magnitude of this effect may suffice to produce a planetographic longitude dependence in observations of the decimeter radio brightness temperature and of the visual and radar albedos. (auth) (UK)

33061 DIFFERENTIAL ROTATION AND THE SOLAR OBLATENESS. Dicke, R. H.; Goldenberg, H. Mark (Palmer Physical Lab., Princeton, N. J.). Nature, 214: 1294-6(June 24, 1967).

Roxburgh (Nature 213: 1077(1967)) questioned an earlier argument by Dicke that the observed flattening of the Sun would account for part of the rotation of the orbit of Mercury otherwise attributable to general relativity. Roxburgh advanced arguments which suggest that the surface of the Sun may not be an equipotential surface, largely because of turbulence in the atmosphere. Dicke rejects this interpretation. (auth) (UK)

33062 THE DETERMINATION OF TRACE ELEMENTS IN METEORITES. Smales, A. A. (Atomic Energy Research Establishment, Harwell, Eng.). Lab. Pract., 16: 701-4(June 1967).

A brief illustrative description of the different types of meteorites is given, together with some comments on their composition, classification, and possible origin, before proceeding to a description of methods particularly useful for the determination of trace elements. Special attention is paid to activation analysis and to mass spectrometric methods, enough detail being given to show the particular advantages of such methods to much wider fields of application than meteorites. The implications of some of the results obtained are discussed, and special reference is made to the most recent fall in the UK, the Barwell meteorite. (auth) (UK)

33063 INVESTIGATION OF THE CLUSTERING OF RADIO SOURCES. Holden, D. J. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 133: 225-8(1966).

An investigation of the possible clustering of radio sources, based on the 4C catalogue, has shown that there is no significant evidence for clustering over the range ½° to 60°. (auth)

33064 STRUCTURE OF THE MAGNETIC FIELD IN THE LOCAL SPIRAL ARM. Hornby, J. M. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 133: 213-24(1966).

General arguments based on the most recently available observational results indicate that the magnetic field in the local spiral arm has a form very similar to that of a tightly wound helix. It is shown that the surveys of the galactic continuum radiation and radio polarization results can be accounted for quantitatively by such a field configuration. A further analysis indicates that if the Galaxy has a radio halo it must be of very large radius. The temperature of the polarized radiation at 1420 Mc is predicted. (auth)

33065 FAINT BLUE STARS IN THE FAR SOUTHERN HEMISPHERE. Hill, P. W.; Hill, S. R. (University Observatory, St. Andrews, Can.). Mon. Notic. Roy. Astron. Soc., 133: 205-11 (1966).

Photoelectric colors and magnitudes of the U, B, V system were measured for sixty-seven Luyten blue stars in the southern hemisphere. The range in V was between $10^{m}.86$ and $13^{m}.80$. Spectral types were determined for fourteen of these stars. The two-color diagram is similar to that for other samples of high-latitude blue stars of the same magnitude range or brighter, in that most of the stars are on or near the main sequence. The sample contains one previously discovered and one probable new white dwarf. (auth)

33066 THE ELECTRON AND POSITRON ENERGY DISTRIBUTION FROM PROTON–ANTIPROTON ANNIHILATION AT REST. Renner, B. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 133: 197-203(1966).

From measurements of the charged pion energy distribution and multiplicities made by Ndili, Westwood, and Forson the multiplicities and energy distributions of electrons and positrons arising through the decays $\pi^{\pm} \rightarrow \mu^{\pm} + \nu$; $\mu^{\pm} \rightarrow e^{\pm} + \nu + \bar{\nu}$ are calculated, and the effect of other channels is estimated. This work is of interest for considering antimatter in the universe. (auth)

33067 GALAXY FORMATION IN A STEADY-STATE UNIVERSE. Hunter, J. H. Jr. (Yale Univ. Observatory, New Haven). Mon. Notic. Roy. Astron. Soc., 133: 181-96(1966).

The condensation problem in a steady-state universe is examined. General solutions are given to the linear hydrodynamical equations including the effect of self-gravitation, cosmic repulsion, thermal conduction, and radiation loss. In addition, approximate solutions to the nonlinear equations are developed in order to follow disturbances that are linearly unstable into the nonlinear range. The principal results of this investigation are: (1) In order for large gas clouds to collapse gravitationally in a steady-state universe from the growth of small disturbances in the Hubble expansion time, the mean density of the uncondensed matter would have to be between ten and one hundred times greater than the density predicted by Hoyle. (2) For certain ranges of temperature, relatively small condensations can form by thermal instability in a steady-state universe. However, the end result of such a collapse is a stable, partially ionized, intergalactic cloud rather than a dwarf galaxy. (auth)

33068 GALACTIC EXPLOSIONS, RADIO GALAXIES, AND QUASI-STELLAR SOURCES. Piddington, J. H. (CSIRO, Sydney). Mon. Notic. Roy. Astron. Soc., 133: 163-80(1966).

Earlier theories of radio galaxies and quasi-stellar radio sources are discussed; most fail to account for the large-scale magnetic field which must be frozen into the relativistic gas. An earlier hypothesis attempted to unify normal spiral galaxies and radio galaxies. This is modified and extended to provide a semiquantitative theory of quasi-stellar sources and other extragalactic radio sources. All may evolve from a contracting, rotating (ω) gas cloud in the presence of a large-scale magnetic field (B), when ω and B are orthogonal. The field is wound into a spiral of ever increasing strength until electromagnetic forces control the size and shape of the galaxy. Rotational kinetic energy is converted to magnetic energy, so that the balance between gravitational and centrifugal forces is destroyed and contraction may continue to nuclear dimensions. However, at no stage is there a sudden collapse, because rotational energy is steadily replenished from gravitational energy which is the original source of all magnetic, cosmic ray, and other energies. The galactic ω dimension is at first much smaller than the disk radius but a spherical stage is reached, followed by an "explosion" along the $\pm\omega$ axis. A number of such explosions may occur at intervals. At all stages of spirality particles are accelerated in a "neutral sheet" where magnetic field is annihilated. At the explosion state the rate may be high (time constant $\sim 10^3$ years) and electrons up to cosmic-ray energies may be released. "Ordinary" radio galaxies are formed if stars are deposited in galactic orbits by the contracting plasma cloud; quasi-stellar sources result when star formation is inhibited so that the whole galaxy shrinks to a nucleus. (auth)

33069 THE SOURCE COUNTS FROM THE 4C SURVEY. Gower, J. F. R. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 133: 151-61(1966).

The source counts derived from the fourth Cambridge catalogue of radio sources (4C) are presented and are combined with previously published results to give the number/flux density (log N/log S) curve over the range of flux density $0.27 < S < 35 \times 10^{-26}$ $w.m^{-2}(c/s)^{-1}$. The correction necessary to take account of confusion is determined by a Monte Carlo process and the corrections for angular diameters of sources and source clustering are also discussed. On the assumption that the form of the source counts can be explained by density variation with epoch, forms of this density variation are derived which would be consistent with the latest derivation of the luminosity distribution function. (auth)

33070 LIFETIME OF BINARY STARS. Yabushita, Shin (Yale Univ. Observatory, New Haven). Mon. Notic. Roy. Astron. Soc., 133: 133-43(1966).

Changes in orbital elements of a binary star by a distant stellar encounter and their cumulative effects are calculated by a similar method to that by Lyttleton and Yabushita for planetary orbits. For close encounters the equations of motion for three bodies with finite masses are integrated numerically on an IBM 7090 for randomly chosen initial conditions which are generated by a Monte Carlo method. For binary stars with total masses equal to one $M_\odot$ equally shared by the components, the probabilities of disruption due to encounters with passing stars with one $M_\odot$ and impact parameters less than the semimajor axes before the encounters are found to be 0.227, 0.028, and <0.002 for binaries with the semimajor axes 10^2, 10^3, and 10^4 A.U., respectively. If the mean stellar density is taken to be 0.1 star/pc as in the solar neighborhood, the lifetime turns out to be 2.92×10^{12}, 2.46×10^{11}, and $>3 \times 10^{10}$ years, respectively. (auth)

33071 LONG-PERIOD VARIABLE STARS. Smak, Jozef. Postepy Astron., 14: 201-19(1966). (In Polish).

A summary is given of recent observational results obtained in the field of the long-period variables. Special attention is given to the following problems: spectral energy distribution and photometric data, absolute magnitudes, galactic distribution and kinematics, and spectroscopic problems. (auth)

33072 STELLAR STRUCTURE AND EVOLUTION. Kubikowski, Jan. Postepy Astron., 14: 169-99(1966). (In Polish).

The results of numerical integrations of stellar structure are reviewed. As the stellar structure is determined by the mass and distribution of the chemical composition, and this last quantity depends on the history of a star, only the stages of evolution are taken into account. It is stressed that in theoretical astrophysics, the numerical integrations of stellar structure play the role of observations. (auth)

33073 PULSATION OF STARS. Dziembowski, Wojciech. Postepy Astron., 14: 149-68(1966). (In Polish).

A review is presented of new progress in the theory of stellar pulsation. The problem of the origin of pulsation is considered by the small perturbation method of star models. The importance of a careful treatment of entropy changes is emphasized. (auth)

33074 TRITIUM DIFFUSION MEASUREMENTS ON PROTON-IRRADIATED SAMPLES OF THE IRON METEORITE SIKHOTE-ALIN. Fechtig, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Festag, J. G.; Schultes, H. Z. Naturforsch., 22a: 765-72(May 1967). (In German).

Samples of the iron meteorite Sikhote Alin were irradiated in the synchrocyclotron at CERN by 600-MeV protons. A concentration of the radioactive isotopes ^{37}Ar and tritium was produced by spallation from iron and nickel nuclei. Diffusion and extraction experiments showed a lack of the produced tritium which may either have been dissolved in the iron at higher temperatures or escaped by diffusion during the irradiation. Also some grains were completely dissolved chemically. The results were that most of the tritium diffused out of the samples during the irradiation, while only a negligible amount of argon was lost by diffusion during the irradiation. Based on this result, the diffusion parameter D/a^2 at room temperature was found to be of the order of 10^{-9} sec^{-1}. The activation energy is in the vicinity of 10 kcal/mol. From these values for the diffusion parameters it can be concluded that the meteorite lost most of the tritium within a few weeks after its fall. (auth)

33075 RARE-GAS MEASUREMENTS ON IRON METEORITES. Schultz, L.; Hintenberger, H. (Max-Planck-Institut fuer Chemie, Mainz). Z. Naturforsch., 22a: 773-9(May 1967). (In German).

The spallogenic isotopes of helium, neon, and argon were measured in 36 iron meteorites using a statically operated-double focusing mass spectrometer. The following relations were found between the concentration ratios of the cosmic-ray produced isotopes ^3He, ^4He, ^{21}Ne, and ^{38}Ar: $^3He/^4He = (36.0 \pm 0.9)\ ^{21}Ne/^4He + (0.148 \pm 0.015)$, $^{38}Ar/^{21}Ne = (9.4 \pm 0.8) \times 10^{-3}\ ^4He/^{21}Ne + (2.06 \pm 0.04)$. From the $^{38}Ar/^{21}Ne$ ratio a parameter n was calculated for each sample which according to Geiss, Oeschger and Schwarz is a number measuring the effective irradiation hardness. Relations between n, $^3He/^4He$, $^3He/^{21}Ne$, and $^4He/^{21}Ne$ were studied. A slight variation of the $^{36}Ar/^{38}Ar$ was found which is correlated to the effective irradiation hardness. The spallation yield of ^{36}Ar relative to the total isobaric yield does not depend on the effective irradiation hardness. (auth)

33076 CONCERNING THE EFFECTIVE GENERATION AND OBSERVATION OF GRAVITATIONAL WAVES. Braginskii, V. B.; Gertsenshtein, M. E. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.), 5: 287-9(May 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 348-50(May 1, 1967).

The question of effective generation of gravitational waves by an electromagnetic field was considered by using the mathematical analogy of the transformation of light in a quadratically nonlinear medium and by investigating the gravitational radiation of moving bodies. (M.O.W.)

33077 HELIUM AND NEON ISOTOPES IN IRON METEORITES AND THE TRITIUM DEFICIENCY IN HEXAHEDRITES. Hintenberger, H.; Schultz, L.; Waenke, H.; Weber, H. (Max-Planck-Institut fuer Chemie, Mainz). Z. Naturforsch., 22a: 780-7(May 1967). (In German).

The He and Ne contents, as well as their isotopic composition, were measured of 40 iron meterorites, including 12 hexahedrites. These hexahedrites were of particular interest because many of them showed a definite ^3He deficiency, explainable by a loss of tritium. This effect was already found previously for the hexahedrite Braunau. The tritium loss depends on the temperature the meteorites were exposed to, hence, on their orbital elements. Some of the hexahedrites have lost practically all their tritium produced during their exposure to the cosmic rays, indicating that they always had been in the vicinity of the Earth or even closer to the Sun. Two octahedrites, Anoka and Staunton, suffered an appreciable loss of tritium too. From the rare-gas data of meteorites with a nearly complete loss of tritium, the cross-section ratios of the direct production of tritium, ^3He, and ^4He by the cosmic rays in iron meteorites could be calculated. (auth)

33078 COSMOLOGICAL DEDUCTIONS FROM OBSERVATIONS OF QUASI-STELLAR SOURCES. Dashevskii, V. M.; Zel'dovich, Ya. B. Soviet Astron. AJ (Engl. Transl.), 11: 52-8 (July-Aug. 1967).

Translated from Astron. Zh., 44: 67-76(Jan.-Feb. 1967).

The possibilities are considered of determining the mean density of matter in the universe from observations of quasistellar sources. The defects of methods using observations of apparent-magnitude or red shift distributions are analyzed. A new method is suggested, involving a count of the number of objects having a given red shift and an apparent magnitude brighter than a certain value. (auth)

33079 GENERAL FEATURES OF CLUSTERS OF GALAXIES. Rudnicki, K. (Univ. of Warsaw, Mt. Wilson Observatory, Pasadena, Calif. Palomar Observatory, Pasadena, Calif. Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Soviet Astron. AJ (Engl. Transl.), 11: 59-62(July-Aug. 1967).

Translated from Astron. Zh., 44: 77-81(Jan.-Feb. 1967).

Several samples of clusters of galaxies with different structures are listed. The following types are considered as extreme: (1) circular-shaped cluster possessing very simple and smooth structure, and a strong segregation effect in brightness (Hydra I); and (2) irregular cluster rich in structural details which does not reveal any segregation effect in brightness (Zwicky 97-8). (auth)

33080 PHOTOMETRIC PROPERTIES OF SUPERNOVAE. Pskovskii, Yu. P. (Astronomical Inst., Moscow). Soviet Astron. AJ (Engl. Transl.), 11: 63-9(July-Aug. 1967).

Translated from Astron. Zh., 44: 82-90(Jan.-Feb. 1967).

A detailed summary is compiled of the photometric parameters for 60 type-I, -II, and -V supernovae. Means are determined for each type, including the mean absolute photographic magnitude M_{SN} at maximum light. The relation is found between M_{SN} and the type of galaxy where each type I supernova outburst occurred. All three types of supernova exhibit a common correlation between the brightness decline rate β and M_{SN}. For type-II supernova β is correlated with the time required for a "hump" to appear in the light curve. (auth)

33081 POSSIBILITY OF FORMATION OF TRIATOMIC MOLECULES IN THE SOLAR ATMOSPHERE. Pande, M. Ch.; Sitnik, G. F. (Astronomical Inst., Moscow). Soviet Astron. AJ (Engl. Transl.), 11: 70-1(July-Aug. 1967).

Translated from Astron. Zh., 44: 91-3(Jan.-Feb. 1967).

The concentration ratios $n(CH)/n(CH_2)$, $n(NH)/n(NH_2)$, $n(C_2)/n(C_2H)$, $n(OH)/n(H_2O)$, $n(CN)/n(HCN)$, and $n(CO)/(HCO)$ are calculated as a function of optical depth in the photosphere for the Utrecht reference model, assuming local thermodynamic equilibrium. The contribution of triatomic molecules is insignificant compared with diatomic molecules. For small departures from LTE one can evidently neglect the depletion of diatomic molecules of type AB and A_2 due to formation of triatomic molecules of type ABH, A_2H, or AH_2. (auth)

33082 SOLAR RADIO EMISSION AT 2 AND 0.2 MHz. Slysh, V. I. (Astronomical Inst., Moscow). Soviet Astron. AJ (Engl. Transl.), 11: 72-4(July-Aug. 1967).

Translated from Astron. Zh., 44: 94-7(Jan.-Feb. 1967).

During the 5 months beginning July 18, 1965, a number of radio bursts were recorded with the Zond 3 space probe at frequencies of 2, 0.21, and 0.02 MHz. The strongest burst, on Oct. 4, was evidently a low-frequency continuation of the type-II burst observed from ground stations. The velocity at which the agency responsible for the radio emission traveled through the corona increased from 2500 to 13,000 km/sec at R = 25 $R_\odot$. Two type-III bursts were identified at 2 MHz. The bursts at 0.21 and 0.02 Mc are listed, but have not been identified with any other phenomena. (auth)

33083 CRITICAL WAVELENGTH IN A SYSTEM OF STARS AND INTERSTELLAR GAS. Maksumov, M. N. (Inst. of Technical Physics, Dushanbe, USSR). Soviet Astron. AJ (Engl. Transl.), 11: 79-83(July-Aug. 1967).

Translated from Astron. Zh., 44: 103-9(Jan.-Feb. 1967).

The critical wavelength λ_{cr} is calculated for an infinite, homogeneous system of stars and interstellar gas in the presence of a uniform magnetic field. An arbitrary function is permitted for the initial stellar velocity distribution; the gas is assumed to move at constant velocity. Two special cases are considered: a Maxwellian distribution, and opposing Maxwellian streams. For the direction of the galactic-rotation axis, λ_{cr} is evaluated for waves in the solar neighborhood. (auth)

33084 KINEMATIC AND MORPHOLOGICAL PROPERTIES OF STARS WITH ENHANCED METAL LINES. Komarov, N. S. (Astronomical Observatory, Odessa). Soviet Astron. AJ (Engl. Transl.), 11: 84-91(July-Aug. 1967).

Translated from Astron. Zh., 44: 110-19(Jan.-Feb. 1967).

The spectral classification, kinematics, absolute magnitudes, intrinsic colors, and rotational velocities of "metallic" stars are considered. The conclusions of [Izv. Krym. Astrofiz. Obs., 29: 181(1963)] are confirmed on the basis of more extensive material. Several new results are obtained: metallic stars form a local system similar to the system of bright B stars. The kinematic properties of metallic stars differ somewhat from normal A stars. A relation is established between the degree of "metallicity" and ultraviolet deficiency. The polar hypothesis cannot explain the spectrum anomalies; hence metallic stars actually have smaller rotational velocities than normal stars. Metallic stars may have a special internal and atmospheric structure. (auth)

33085 NORMAL CEPHEID COLOR INDICES. II. Nikolov, N. S. (Astronomical Inst., Moscow. Univ. of Sofia). Soviet Astron. AJ (Engl. Transl.), 11: 92-8(July-Aug. 1967).

Translated from Astron. Zh., 44: 120-8(Jan.-Feb. 1967).

Normal (U−B) color indices are derived for 59 Cepheids from the $(B-V)_0$ colors obtained previously. The curvature of the reddening lines in the [(U−B), (B−V)] diagram is taken into account. A $[(U-B)_0, \log P]$ relation is obtained similar to that observed between spectrum and log P, and between normal (B−V) color index and log P. The location of Cepheids in the two-color diagram is discussed. A correlation between the ultraviolet excess at maximum and the amplitude of the Cepheid light curve is found. (auth)

33086 SPACE DISTRIBUTION OF DIFFERENT TYPES OF STARS IN THE GLOBULAR CLUSTER M 13. Yakimov, V. E. (Astronomical Inst., Moscow). Soviet Astron. AJ (Engl. Transl.), 11: 99-102(July-Aug. 1967).

Translated from Astron. Zh., 44: 129-33(Jan.-Feb. 1967).

The space distribution of M 13 stars is derived from their apparent distribution. The star density is obtained as a function of distance from the cluster center for three groups of stars: negative color index, and positive color index with apparent magnitudes $m_A < 15^m.8$ pg or $15^m.8 < m_B < 17^m.0$ pg. von Zeipel's method yields different masses for group A and B stars: $M_B = 0.60\ M_A$. The group A stars form a more concentrated subsystem in the cluster than the stars with negative color index. (auth)

33087 APPARENT STELLAR DENSITY DISTRIBUTIONS IN SOME OPEN CLUSTERS. Panarin, Yu. P. (Astronomical Inst., Moscow). Soviet Astron. AJ (Engl. Transl.), 11: 103-6(July-Aug. 1967).

Translated from Astron. Zh., 44: 134-8(Jan.-Feb. 1967).

For several open clusters, apparent density distribution functions are derived for groups of member stars occupying different positions in the color−magnitude diagram. The apparent star density is approximated by $F = F_0 \times 10^{-kr}$, where r is the distance from the cluster center and k is a parameter. If t is the cluster age, N the number of member stars, and r_1 the cluster radius, then the correlation coefficient of k with log t is $\rho = -0.40$; with $\sqrt{N}/r_1$, $\rho = 0.93$. The significant correlation $\rho = 0.70$ is found between the ratio $\Delta k/\Delta M_V$ and log t, where ΔM_V is the difference in the mean magnitudes of star groups belonging to the same cluster and Δk is the difference in the values of k for these groups. (auth)

33088 PRECISE MEASUREMENT OF LUNAR RADIO EMISSION AT 1.8, 2, AND 2.5 cm. Plechkov, V. M. (Gorky State Univ., USSR). Soviet Astron. AJ (Engl. Transl.), 11: 119-21 (July-Aug. 1967).

Translated from Astron. Zh., 44: 154-7(Jan.-Feb. 1967).

Measurements made by the "artificial moon" method yielded the following phase dependences of effective lunar temperature, averaged for the disk: at 1.8 cm $\overline{T}_{moon} = 202° + 24° \cos(\Phi - 30°)$; at 2.0 cm $\overline{T}_{moon} = 206° + 19° \cos(\Phi - 56°)$; at 2.5 cm $\overline{T}_{moon} = 210° + 15.5° \cos(\Phi - 42°)$. The lunar phase Φ is reckoned from the full moon. The accuracy of measuring the absolute lunar temperature is ±5%. (auth)

33089 GRAVITATIONAL CAPTURE OF COSMIC DUST BY THE SUN AND PLANETS AND EVOLUTION OF THE CIRCUMTERRESTRIAL CLOUD. Radzievskii, V. V. (Gorky State Pedagogical Inst., USSR). Soviet Astron. AJ (Engl. Transl.), 11: 128-36(July-Aug. 1967).

Translated from Astron. Zh., 44: 166-77(Jan.-Feb. 1967).

Without invoking any hypothesis, the inevitability of permanent, purely gravitational capture of cosmic dust by the sun with the assistance of the planets, and by the planets with the assistance of their satellites is demonstrated. An approximate quantitative computation of the captured mass is made; for each auxiliary body it is dependent only on the spatial density (ρ) of the captured matter and on the velocity of the particles at infinity (v_∞). For example, with a density of the galactic medium $\rho_g \geq 4 \times 10^{-27}$ and $v_\infty \leq 2 \cdot 10^6$, by means of the planets of the Jovian group the sun captures a quantity of matter completely adequate for sustaining the zodiacal cloud. The earth, with the assistance of the moon, captures three orders of magnitude more zodiacal matter than is necessary for sustaining the circumterrestrial cloud with the experimentally observed density. It is postulated that a small part of the particles captured by the earth enter geocentric orbits with eccentricities close to zero. Such particles, under the influence of the planetocentric effect of radiative deceleration, gradually spiral toward the earth, forming a circumterrestrial dust cloud with a density inversely proportional to the cube of the distance from the center of the planet. The geocentric orbits of most of the captured particles are so elongated that in the segment near perigee they plunge into the zone of the earth's radiation belt, where the particles are subjected to intense fragmentation, leading to a sharp increase of the relative role of light pressure of solar rays. As a result, the apogee regions of the orbits of the products of fragmentation of particles are outside the zone of the earth's influence. The products of fragmentation of particles are expelled by light pressure and form the gas−dust tail of the earth. The total mass of this tail is estimated and found to be fully adequate (about 3 tons) to cause a number of observable optical effects. (auth)

33090 ABUNDANCE OF HELIUM IN THE SUN. Lambert, D. L. (Oxford Univ.). Nature, 215: 43-4(July 1, 1967).

It is stated that the origin of helium remains a major problem. Hoyle and Taylor have concluded that most of the helium in our Galaxy was synthesised not in stellar interiors but either in the primordial fireball or in a massive object which preceded star formation. The present authors report the results of a re-determination of the abundance of helium in the Sun, and also review data on the abundance in other bodies. It is stated that the available evidence suggests that stellar nucleosynthesis was responsible for the increase in helium abundance in interstellar gas between formation of the Sun and the present time, but no final conclusions on the origin of helium can be proposed. The initial abundance for the Galaxy before the formation of stars is uncertain. (UK)

33091 SCALAR GRAVITATIONAL FIELDS IN PULSATING STARS. Morganstern, R. E. (State Univ. of New York, Stony Brook); Chiu, Hong-yee. Phys. Rev., 157: 1228-32(May 25, 1967).

Brans and Dicke have suggested the existence of a scalar field in their theory of gravitation. The role of a scalar gravitational field in pulsating stars is studied. It is found that a star in a radially symmetric pulsational motion can radiate scalar waves but not gravitational waves. Further, radiation of scalar waves can damp out the radial pulsation of a neutron star in a matter of seconds. Thus, if a neutron star is found to pulsate, then the existence of a scalar field can be ruled out. (auth)

33092 COSMOLOGICAL MODEL WITH BOTH RADIATION AND MATTER. McIntosh, C. B. G. (Univ. of New England, Armidale, Australia). Nature, 215: 36-7(July 1, 1967).

Previous models of the Universe based on the "big bang"

theory have set various times for the period when the density of matter became equal to the density of radiation. The model described sets this limit at about 6.7% of the present age of the Universe, and has the advantage that it explains what happened in the early as well as the late stages of the life of the Universe. (auth) (UK)

33093 SURFACE HELIUM ABUNDANCE IN HORIZONTAL BRANCH AND HALO B STARS. Faulkner, J. (Cambridge Univ., Eng.); Iben, I. Nature, 215: 44-5(July 1, 1967).

The surface helium abundance of stars at the blue end of the horizontal branch in globular clusters, and of halo B stars, has been estimated spectroscopically to be lower than at the surface of the Sun by factors of 10 to 100. It has been suggested that diffusion in these slowly rotating stars may establish a pronounced stratification of elements near the surface, and that for this reason the helium abundance at the photosphere would be considerably smaller than in the interior. It has also been shown that, for main sequence O and B stars, and for Be stars, the weakness of helium lines is correlated with their narrowness. Because meridional circulation induced by rotation tends to counter the effects of diffusion inward, these results lend support to the argument that diffusion may have been effective in depleting the abundance of helium at the surface of sharp-lined blue horizontal branch stars. If the helium deficiency factor is ~100 it is a clear indication that there is an effective mechanism depleting surface abundance. On the other hand, a factor of 10 could be consistent with the assumptions that globular cluster stars began life with a vanishingly small helium content, and that no effective depletion mechanism has been operating. These and other considerations are discussed. (UK)

33094 DETECTION OF A NEW MICROWAVE SPECTRAL LINE. Palmer, P.; Zuckerman, B.; Penfield, H.; Lilley, A. E.; Mezger, P. G. Nature, 215: 40-1(July 1, 1967).

During studies on the presence of helium in radio sources unidentified microwave spectral emission was observed in NGC 2024 and IC 1795, close to the expected position of the recombination line 109α of carbon I. The observed physical characteristics of this emission are described, and its possible origins considered, together with further studies to identify it. Reasons are given why this new line is unlikely to be a recombination line of hydrogen or helium, and consideration is given as to whether it can be a recombination line originating from atoms, ions, or molecules with mass greater than helium, possibly from carbon I. (UK)

33095 POPULATION OF ATOMIC LEVELS BY DIELECTRONIC RECOMBINATION. Goldberg, L.; Dupree, A. K. Nature, 215: 41-3(July 1, 1967).

Palmer et al. (Nature 215: 40–41) reported an emission line close to the expected position of the recombination line 109α of carbon I in the radiofrequency spectra of the ionized hydrogen regions of radio sources NGC 2024 and IC 1795. The total intensity of this line was about 3% of that of the neighboring 109α line of hydrogen I. If the line is indeed the 109α line of carbon I its observed intensity relative to that of the same transition in hydrogen is at least 60 times greater than would be expected from considerations of thermodynamic equilibrium and normal cosmic abundances. It is stated that the apparent anomalous overpopulation of the n = 110 level of carbon I can be explained as a result of departures from thermodynamic equilibrium which result in the preferential population of levels of high total quantum number by dielectronic recombination. These considerations are discussed in detail. (UK)

33096 STRONG X-RAY SOURCE IN THE VICINITY OF THE CONSTELLATION CRUX. Harries, J. R.; McCracken, K. G. (Univ. of Adelaide). Nature, 215: 38-40(July 1, 1967).

Data obtained during the flight of two Skylark rockets from Woomera are given. The x-ray detection systems and their method of use are described. In addition to observation of x rays from the Sagittarius cluster and Sco XR-1, both flights detected x rays from an object at a high negative declination, in the vicinity of the constellation Crux. The energy spectrum appeared to be softer than that of Sco XR-1. Both the new source and Sco XR-1 were found to be very bright compared with the remainder of the known celestial x-ray objects, and both possess very soft spectra, suggesting that they are of similar physical nature. (UK)

33097 OBSERVATIONS OF QUASARS USING INTERFEROMETER BASELINES UP TO 3,074 km. Broten, N. W. (NRC, Ottawa); Locke, J. L.; Legg, T. H.; McLeish, C. W.; Richards, R. S.; Chisholm, R. M.; Gush, H. P.; Yen, J. L.; Galt, J. A. Nature, 215: 38(July 1, 1967).

From measurements made with a baseline of 120 km at wavelength 6 cm. it was demonstrated that some quasars have angular diameters less than 0.025 sec. arc. It is not only desirable to improve the resolving power at cm wavelengths but, in view of theories which predict that the observed diameter of a quasar should increase with wavelength it is important to achieve comparable resolution at longer wavelengths, which implies the use of very long baselines. With conventional interferometers employing land lines or microwave links it is difficult to preserve the phase of the signals for distances greater than a few hundred km. It is also difficult to compensate for the large and variable time delay between reception of the signals at the two telescopes. These difficulties have been overcome by the use of wide-band magnetic tape recorders and independent local oscillators controlled by rubidium frequency standards. Using an interferometer of this type, observations were made on the quasar 3C 273B at 448 Mc, with a baseline of 3,074 km ($4.6 \times 10^6\lambda$). Assuming a Gaussian source model the visibility of the fringes indicates that the diameter of this source is <0.02 sec arc at this frequency. Fringes were also observed from 3C 345, using this baseline. Observations at 448 Mc, with a baseline of 183 km. ($2.7 \times 10^5\lambda$), were made on other sources, indicating a maximum angular diameter of about 0.3 sec arc. (UK)

33098 THE NATURE OF AG PEGASI. Boyarchuk, A. A. (Crimean Astrophysical Observatory, Moscow). Soviet Astron. AJ (Engl. Transl.), 11: 8-15(July-Aug. 1967).

Translated from Astron. Zh., 44: 12-21(Jan.-Feb. 1967).

The light curve and spectral variations of AG Peg are described. A unified model will explain the basic observational data: AG Peg is a binary star consisting of a normal M3 III giant and a hot, low-luminosity WN6 star similar to a planetary-nebula nucleus. The hot component began to flare in 1850, and by now a distinctive planetary nebula surrounding both components has been formed. (auth)

33099 SPECTROPHOTOMETRY OF RZ SCUTI. Karetnikov, V. G. (Astronomical Observatory, Odessa). Soviet Astron. AJ (Engl. Transl.), 11: 16-22(July-Aug. 1967).

Translated from Astron. Zh., 44: 22-30(Jan.-Feb. 1967).

Previous work on RZ Sct is reviewed briefly and the results of various analyses of this variable are surveyed. Spectroscopic observations are reported. The spectral energy distribution is determined, the Balmer jump is estimated, equivalent widths are measured for the hydrogen lines and some helium, calcium, and other lines, and the ion density in the gaseous envelope of the system is computed. The results of photoelectric observations made in 1961 are discussed. (auth)

33100 SOME EVOLUTIONARY PATTERNS FOR CLASSICAL CEPHEIDS. Efremov, Yu. N.; Kopylov, I. M. (Astronomical Council, Moscow. Crimean Astrophysical Observatory, Moscow). Soviet Astron. AJ (Engl. Transl.), 11: 23-6(July-Aug. 1967).

Translated from Astron. Zh., 44: 31-4(Jan.-Feb. 1967).

Data are revised for 11 star clusters and associations containing 19 Cepheids as possible members. The Cepheids have an M_V fainter by $0^m.5$ than given previously, because the intital main sequence is used. Estimates are made of the cluster ages and the time spent by the Cepheids on and off the main sequence. The longest time a star can remain a Cepheid (with a 3 to 10-day period) is (1 to 3) $\times 10^7$ yr. However, a star spends only 10 to 20% of this time in the instability band, which it enters repeatedly. One no longer need assume that only 3 to 5% of all B stars become Cepheids. (auth)

33101 DETECTION AND INVESTIGATION OF THE 5-cm EXCITED-HYDROGEN RADIO LINE (n_{105}–n_{104}) IN SEVERAL GALACTIC NEBULAE. Dravskikh, A. F.; Dravskikh, Z. V. (Central Astronomical Observatory, Pulkovo, USSR). Soviet Astron. AJ (Engl. Transl.), 11: 27-32(July-Aug. 1967).

Translated from Astron. Zh., 44: 35-41(Jan.-Feb. 1967).

Observations of the 5-cm excited-hydrogen radio line are reported. Line profiles for the Omega and Orion Nebulae and in the direction of the galactic center are presented. The profiles yield kinetic temperatures of 5200, 6400, and 4300°K respectively. The galactic-center line emission does not come from the central feature. (auth)

33102 COHERENT SYNCHROTRON MECHANISM FOR RADIO EMISSION FROM COSMIC SOURCES. Zheleznyakov, V. V. (Gorky State Univ., USSR). Soviet Astron. AJ (Engl. Transl.), 11: 33-42(July-Aug. 1967).

Translated from Astron. Zh., 44: 42-54(Jan.-Feb. 1967).

A coherent synchrotron mechanism is described for the radio emission from various cosmic sources (quasars with a composite spectrum, the local Crab Nebula source, UV Ceti flare stars, solar continuum-group radio emission). The result that a system of relativistic electrons in a medium (plasma) can possess negative reabsorption for an appropriate energy spectrum is used. The co-

herent synchrotron mechanism can then yield radio emission of an intensity exceeding the combined intensities of the individual radiating particles. The radio emission of the quasar CTA 102 can be explained by the coherent synchrotron mechanism if the source diameter L is estimated from the variability of the radio emission ($L \gtrsim 0.1$ pc). The noncoherent synchrotron mechanism would be unrealistic here, unless CTA 102 were much larger in size ($\gtrsim$50 pc). The parameters for the millimeter-wave source in the quasar 3C 273B show that the coherent synchrotron mechanism could yield the observed variable radio emission if an extremely high plasma concentration and temperature ($N \approx 10^{12}$ el/cm^3, $T \gtrsim 5 \cdot 10^9$ °K) obtain in a region measuring $L \approx 0.01$ pc. However, the x-ray bremsstrahlung from a source having these parameters would be several orders stronger than the x-ray flux from the most intense local sources in the sky. On the other hand, the noncoherent synchrotron mechanism would prevail only for $L \gtrsim 0.3$ pc, a value difficult to reconcile with the variability of 3C 273B. The parameters are given for the local source in the Crab Nebula; the coherent mechanism would require no unusual conditions, unlike the noncoherent mechanism, which is completely unrealistic. For the flare star V 371 Ori, the coherent mechanism would operate efficiently for moderate electron energies and concentrations in a medium whose properties resemble the upper layers of the solar corona. It is also necessary for interpreting the powerful type IV bursts ($T_{eff} \approx 10^{12}$ °K) in sporadic solar radio emission. (auth)

33103 THE OPTICAL SPECTRUM OF THE QUASI-STELLAR RADIO SOURCE 3C 345. Dibai, E. A.; Esipov, V. F. (Astronomical Inst., Moscow). Soviet Astron. AJ (Engl. Transl.), 11: 43-4(July-Aug. 1967).

Translated from Astron. Zh., 44: 55-7(Jan.-Feb. 1967).

The spectral lines are identified and the red shift is determined for the quasi-stellar radio source 3C 345. (auth)

33104 NATURE OF THE X RADIATION OF RADIO GALAXIES. Shklovskii, I. S. (Astronomical Inst., Moscow). Soviet Astron. AJ (Engl. Transl.), 11: 45-51(July-Aug. 1967).

Translated from Astron. Zh., 44: 58-66(Jan.-Feb. 1967).

The possible mechanisms of x radiation of the radio galaxies Cygnus A and Virgo A are analyzed. This is done by an investigation of the physical conditions in the "optical" condensations of Cygnus A, particularly the mass of gas present there, which is ~ 1 to $3 \times 10^8 M_\odot$. The possible cause of the x radiation of Cygnus A may be thermal radiation (bremsstrahlung) at the central part of this source. The observed continuous spectrum of the central part of Cygnus A is a continuation of this radiation in the optical frequency range. The mass of hot ($T_e \sim 5 \times 10^7$) plasma should be $>10^{11} M_\odot$. The relatively dense, cold condensations in this plasma gibe the observed optical radiation. These condensations are similar in nature to the "stationary condensations" in Cassiopeia A. (auth)

33105 FORMATION OF SOLAR PROMINENCES. Krishnaswamy Raju, Prativadibhayankaram. New Haven, Yale Univ., 1966. 89p.

Thesis.

A nonlinear treatment of prominence condensation from the corona by means of thermal instability is presented. It is found that the prominence stage is reached after times of the order 10^6 seconds. The major limitations on the process are due to magnetic fields; if the initial field strength is below 10^{-4} gauss, heat conduction by free electrons prevents the formation of condensations. On the other hand, fields above 10^{-1} gauss prohibit a significant density increase. It is suggested that the observed density values develop from secondary processes, after the temperature has reached prominence values as a result of initial thermal instability. (TSS) (Disser. Abstr)

33106 NEUTRINO EMISSION FROM DENSE STELLAR INTERIORS. Hansen, Carl John. New Haven, Yale Univ., 1966. 184p.

Thesis.

Some neutrino-producing mechanisms are discussed which are of importance in dense stellar interiors. The rates of neutrino emission from electron decay and capture, and position decay (the nuclear URCA processes) are computed for the ranges of density and temperature $10^6 \leq \rho \leq 10^{10}$ gm/cm^3 and $10^8 \leq T \leq 10^{10}$ °K for 200 nuclei with mass numbers $A = 12$ to 61 clustered around the beta-stable valley. Some applications to stellar evolution and element abundance calculations are touched upon. Finally, tables of fitting coefficients are derived whereby the user may generate his own rates with a minimum of labor. The rate for the modified URCA process ($n + n \rightarrow n + p + e^- + \bar{\nu}$, and its inverse) is derived which is important in the density regime $10^{13} \leq \rho \leq 10^{16}$ gm/cm^3. The result is used to compute the rates of decrease of thermal and oscillatory energies of vibrating neutron stars in an effort to account for the energy source of x-ray emission observed from known supernova remnants. The conclusion is reached that neutrino losses decrease neutron star surface temperatures below the observed limit in a very short time. On the other hand, damping of oscillations by the same mechanism does not appear to be fast enough to rule out a vibrational source of energy. Calculations of neutrino losses from pair annihilation, plasmon decay and photon–electron scattering are given in an appendix. Additional appendices contain calculations of elementary particle abundances in neutron stars, and a method for computing total nuclear radiation widths. Numerical results for the latter agree very well with observed widths. (Disser. Abst.)

33107 FOKKER–PLANCK TREATMENT OF THE EVOLUTION OF THE GLOBULAR CLUSTER IN ENERGY AND ANGULAR MOMENTUM SPACE. Easton, Paul Donald. Waltham, Mass., Brandeis Univ., 1966. 93p.

Thesis.

A simplified derivation of the Fokker–Planck velocity coefficients in the homogeneous case is presented. This involves a perturbation treatment of the stellar interactions, keeping only lowest order terms in the gravitational coupling constant. The method is then extended to the derivation of the Fokker–Planck coefficients in energy and angular momentum for the inhomogeneous case. It is shown that for a typical cluster it is reasonable to consider only interactions with field stars which pass through a region about the test star within which the stellar distribution is approximately homogeneous. Thus the determination of the Fokker–Planck coefficients reduces to integration over a test star orbit of the local Fokker–Planck coefficients for homogeneous field star distributions. This approximation makes a numerical calculation practical. Using a quantitative model of a typical globular cluster, with a radial cutoff at 100 parsecs to simulate the effects of galactic tides, the rate of mass loss and the rate of change of the E–J space distribution function is calculated. From the latter quantity the rate of change of the space density distribution is determined. It is found that the density increases within a small region near the center, decreases over an intermediate region that contains most of the mass, and increases again in the outlying portions. A parallel calculation is done for the rate of mass loss using the approximation, which is frequently made, that the true field star distribution may be replaced by a truncated Maxwellian distribution. The result is too high by a factor of four. (Disser. Abst.)

33108 ROCKET OBSERVATIONS OF THE SUN IN THE LIGHT OF LYMAN ALPHA. Sloan, William Adamson. New Haven, Yale Univ., 1966. 111p.

Thesis.

A Cassegrain telescope with a resolution of two seconds of arc was successfully flown in an Aerobee-Hi rocket from White Sands Missile Range on 20 October, 1965. A pinhole 33 microns in diameter, was placed at the focus of the telescope, followed by a photoionization detector with a lithium fluoride window. The instrument was kept pointed at the sun by a biaxial solar pointing control. Results indicate that in Lyman alpha the solar surface shows structures whose characteristic dimensions can be as low as 2 seconds of arc, which corresponds to the limit of instrument resolution. Larger structures with very sharp gradients have also been found. Intensity ratios between bright and dark areas are typically a factor of 1.7. Isophote maps of two small selected areas are discussed. (Disser. Abst.)

33109 STRUCTURE OF THE OUTER ATMOSPHERE OF COOL STARS. Ulmschneider, Peter Hermann. New Haven, Yale Univ., 1966. 144p.

Thesis.

The production of acoustic noise in stellar convection zones is shown to give rise to stellar coronas, stellar winds and uv radiation. Moreover it is found that the detailed structure of the outer atmospheres of stars is completely determined by this noise flux and that it consequently can be predicted for not-too-luminous stars of late spectral class. (Disser. Abst.)

33110 ROTATING MASSES AND THEIR EFFECT ON INERTIAL FRAMES. Cohen, Jeffrey M. New Haven, Yale Univ., 1966. 65p.

Thesis.

An analysis is given of the stress-energy tensor and geometry produced by slowly rotating bodies. The geometrized mass (GM/C^2) of the body is allowed to be comparable to its radius. The geometry is treated as a perturbation of the Schwarzschild geometry. This leads to considerable simplification of Einstein's equations. The rotation of the inertial frames induced by a rotating massive shell is calculated and discussed with particular attention to two limiting cases: (1) For small masses it reduces to Thirring's well-known result. (2) For large masses, whose Schwarzschild radius approaches the shell radius, the induced

rotation rate approaches that of the shell. These results are examined for their consistency with particular interpretations of Mach's principle. The analytic extension of the rotating metric is a completely source-free rotating solution. It describes a slowly rotating Einstein–Rosen bridge, which can be taken as a geometrodynamic model for a slowly rotating body. This thesis also includes an extensive discussion of Cartan frames and exterior differential forms. These modern mathematical tools expedited both the calculations and the physical interpretation. (Disser. Abst.)

33111 THERMONUCLEAR REACTIONS IN SUPERNOVA SHOCK WAVES. Truran, James Wellington. New Haven, Yale Univ., 1966. 156p.

Thesis.

The influence of a supernova shock wave on the abundances of the nuclear species present in the stellar medium is considered. The temperature of the medium immediately behind the shock may typically be $\sim 5 \times 10^9$ °K. Nuclear reactions proceeding on the products of earlier nuclear-burning phases can result in the formation of heavier nuclei. In order to follow these nuclear transformations, a nuclear reaction network is established providing suitable reaction links connecting neighboring nuclei. Thermonuclear reaction rates are determined for all neutron, proton, and alpha-particle reactions involving the nuclei in this network from a consideration of the statistical properties of nuclei. The calculated rates are compared with experiment both for charged particle reactions on lighter nuclei and for neutron capture reactions proceeding on nuclei in the mass range $A > 60$. Good agreement is obtained in both cases. Employing these calculated values of the rates in the nuclear reaction network, the effect of a peak shock temperature of 5×10^9 °K on regions of ^{12}C, ^{16}O, ^{28}Si, and ^{32}S is studied. It is shown that the nuclei in the silicon to calcium mass region can be formed by this mechanism. The observed solar and meteoric abundances display a broad peak in the vicinity of iron, the most abundant nucleus in this region being ^{56}Fe. In these calculations, ^{54}Fe is determined to be the most abundant isotope in this mass range. It is suggested that at somewhat higher densities, $\rho \sim 10^8$ to 10^9 gm.cm^{-3}, electron capture on ^{32}S may produce large quantities of ^{32}Si before the passage of the shock. The increased ratio of neutrons to protons in the system may lead to the production of large amounts of ^{56}Fe, rather than ^{54}Fe. (Disser. Abst.)

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Refer also to abstracts 33544 and 34031.

33112 (AAEC/E-159) THE MEASUREMENT OF CHARGE TRANSFER CROSS SECTIONS FOR HIGH ENERGY (~1 MeV) PROTONS AND HYDROGEN ATOMS INCIDENT UPON HYDROGEN AND HELIUM GASES. Williams, J. F. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Sept. 1966. 30p. Dep.

Measurements of the single and double electron capture cross sections for protons, σ_{10} and σ_{1-1} respectively, and the single electron loss cross section for hydrogen atoms, σ_{01}, within the energy range 0.25 to 2.5 MeV for hydrogen and helium target gases are reported and compared with published theoretical estimates and experimental values. The present values of σ_{10} and σ_{01} agree well with the data of Barnett and Reynolds below 1 MeV. The extrapolation of the data of Barnett and Reynolds to pass through the single value at 10 MeV by Berkner is confirmed. The experimental values of σ_{01} agree with calculations that use the Born and free-collision approximations within the experimental uncertainty of ±10%. The values of σ_{1-1} decrease from 5.1×10^{-25} cm^2/mol at 0.4 MeV to 1.6×10^{-28} cm^2/mol at 1.0 MeV with an experimental uncertainty of up to a maximum of 60%. These values are lower than, but exhibit a similar dependence on proton energy to, the first Born-approximation calculations by Mittleman. A detailed discussion is given of the experimental accuracy. The cross sections were measured by observing the rate of growth with target gas number density of the fast collision products from an originally pure primary beam. The apparatus was developed for use at pressures less than 10^{-8} mmHg by baking at 400°C. It was designed for measuring a wide variety of charge-changing collisions. (auth)

33113 (AD-628922) ELECTRONIC STRUCTURE AND ENERGY LEVELS OF MANY ELECTRON ATOMS. Final Scientific Report. Midtdal, John (Oslo Univ. (Norway). Inst. for Theoretical Physics). Jan. 25, 1966. Contract AF-EOAR-32-64. 8p. (AFOSR-66-0362). CFSTI.

The document is comprised of abstracts of results (published elsewhere) of work in the following areas: theoretical and numerical investigations of two-electron atoms and ions, with perturbation theory expansions of their energies and wave functions; theoretical investigations of the rotational energy of the asymmetrical top; quantum particle dynamics and scattering problems in quantum mechanics. (auth) (TAB)

33114 (AD-640388) EIGENVALUES AND FUNCTIONS FOR A MODIFIED COULOMB POTENTIAL. Buckingham, R. A.; Bernal, M. J. M.; Mills, B. M. (London Univ. (England). Computer Unit). Sept. 30, 1959. Contract AF61(052)-151. 19p. CFSTI.

The Schroedinger equation for a single electron in the field of a point charge Z2e and of a charge Z1e distributed uniformly over a concentric sphere of radius R is solved numerically for various values of the parameters $\alpha = Z1/Z2$ and $X = Z2R$. The energy eigenvalues for the 2s, 2p, 3s, 3p, 3d states are tabulated for $\alpha = -0.75\ (0.25)1.0$ and $X = 0(2)20$. (auth) (TAB)

33115 (AD-644613) ON THE BETHE–HEITLER FORMULA FOR BREMSSTRAHLUNG. Hylleraas, Egil A. (Oslo Univ. (Norway). Inst. for Theoretical Physics). Sept. 1962. Contract AF61(052)-134. 18p. (ARL-62-478). CFSTI.

In dealing with radiation problems one often meets with fairly inconvenient formal obstacles requiring long and tedious explanations which as a rule are omitted in textbooks. This obscures considerably the real connection between basic conceptions and end formulae. In the author's opinion the Bethe–Heitler formula for bremsstrahlung is one of the most striking examples of that sort, the reason for the troubles being mainly that during the process of deduction there is an overcrowding of mutually cancelling terms. The aim of this exposition is to let the final terms appear at the earliest possible stage. Of secondary interest is to remember how the rest of terms are cancelling. (auth)

33116 (JINR-P1-3190) FLYUKTUATSII IONIZATSIONNYKH POTER' (TABLITSY). (Fluctuations of Ionization Losses (Tables)). Golovin, B. M.; Kulyukina, L. A.; Medved, S. V.; Pavlovich, P.; Shulek, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 180p. (In Russian). Dep.

The functions for the ionization loss distribution of heavy charged particles in Be, C, CH, CH_2, Al, Cu, and Pb are tabulated in wide intervals of particle energy and stopping-material thickness. (auth)

33117 (JINR-P4-3297) O REZONANSNOM VZAIMODEISTVII DVUKH IDENTICHNYKH DIPOL'NYKH IZLUCHATELEI. (On Resonance Interaction of Two Identical Dipole Emitters). Lyuboshits, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 23p. (In Russian). Dep.

The problem is solved of the emission spectrum of two isotropic oscillators at an arbitrary distance from each other. A resonance dipole interaction between 2 two-level stationary centers is considered. The energy and width values of collective states of one of the centers are obtained. The structure is considered of energy levels of a molecule with two identical nuclei, one of which is in an excited state and the other in the ground state. It is shown that the lifetime of an excited nucleus depends on quantum numbers characterizing the motion of nuclei in the molecule. (auth)

33118 (JINR-P7-3355) O VOZMOZHNOSTI ISPOL'ZOVANIYA OZHE-NEITRALIZATSII DLYA IDENTIFIKATSII MNOGOZARYADNYKH IONOV. (On the Possibility of Using the Auger-Neutralization for Multiple Charged Ions Identification). Parilis, E. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 11p. (In Russian). Dep.

An evaluation of the Auger-electron emission when a multiply charged ion approaches a metal surface shows that it is possible in principle to use this phenomenon for identification of the multiply charged ions on the background of singly charged ones. In the synthesis of transuranium elements accelerators of heavy multiply charged ions are used. When analyzing an ion beam with the help of a mass analyzer with low resolving power separation by e/m takes place and the pairs of singly and multiply charged ions corresponding to equal or near values of this ratio (Kr^{+7}_{84} and C^{+1}_{12}, Kr^{+10}_{84} and O^{+2}_{16}, Xe^{+10}_{131} and C^{+1}_{13}, Xe^{+9}_{131} and N^{+1}_{14}, U^{+13}_{238} and O^{+1}_{16}, etc.) find themselves in one beam. There arises the problem of their discrimination by charges. According to theoretical calculations for some pairs the difference in electron emission under two ions forming the pair is very great. It should be noted that these values are quite approximate and must be taken only by their order of magnitude. (auth)

33119 (KFKI-9/1967) INVESTIGATION OF CONDENSED AQUEOUS SYSTEMS BY MOESSBAUER EFFECT. Dezsi, I.; Keszthelyi, L.; Molnar, B.; Pocs, L. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1967. 39p. Dep.

Solidified solutions of various ^{57}Fe ions in high spin state have been investigated by measuring their Mössbauer spectrum. The close values of the quadrupole splitting and the isomeric shift

obtained at −191°C are an indication of the similar symmetries around these ions at this temperature. The temperature dependence of the Mössbauer parameters, namely, intensity, quadrupole splitting and line width, exhibits a remarkable change at about −90°C in the solid solutions under investigation except for that of Mohr salt for which this change occurs at −62°C. For the pure crystalline hydrates of dissolved iron salts no similar change takes place. The change in the temperature behavior suggests a structural transformation to occur at this temperature, probably recrystallization, involving a violent atomic diffusional motion. This conjecture is supported by the fact that the isothermal time behavior of the changes observed is similar to the S-shaped curve obtained by other methods for structural transformations. (auth)

33120 (N-66-37561) DIPOLE TRANSITION INTEGRALS FOR NON-METAL RESONANCE TRANSITIONS. Lawrence, G. M. (Princeton Univ., N. J. Observatory). Apr. 20, 1966. 18p. (NASA-CR-78378). CFSTI.

By formulating a numerical analog of the Bates−Damgaard Coulomb approximation for dipole transition probabilities, but with a Thomas−Fermi potential, transition probabilities are calculated for $p^n-p^{n-1}.s$ transitions as a function of empirical energies. The variation of the calculated values with atomic number is found to be approximately factorable. The formulation obtains radial wavefunctions by solution of an initial value problem. Extension of the Bates−Damgaard tables are given for p ground states and s excited states of neutral atoms. The scaled Thomas−Fermi or quantum defect methods are recommended for ions. For intermediate weight atoms, agreement with experiment is found within 30%. Errors of 40% or more are found in C, N, Pb, and I, where failure of the configuration assignments is the probable cause. The Burgess−Seaton quantum defect method is found to give results from −10% to +80% different from the present formulation. (auth)

33121 (ORO-1316-24) EXCITATION OF n = 4 AND n = 5 STATES IN He(II). Jordan, J. A. Jr.; Yager, R. E.; Bakken, G. S. (Rice Univ., Houston, Tex. Dept. of Physics). Jan. 1967. Contract AT(40-1)-1316. 7p. (CONF-670702-4). Dep. CFSTI.

From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR.

A monoenergetic, high-velocity helium ion beam was used to determine excitation cross section in fast-ion collision processes. The beam passes through a thin carbon foil where some of the beam atoms are promoted to excited states, which decay with appreciable radiation downstream of the foil. A plot of the intensity of a given spectral line against the distance to the foil from the point of observation in the beam provides a well-resolved decay curve of the higher energy state. (M.H.R.)

33122 (ORO-2911-8) THE INTERACTION OF HEAVY keV IONS WITH GASES. Progress Report, June 1, 1966-May 31, 1967. Boring, John W. (Virginia Univ., Charlottesville. Research Labs. for the Engineering Sciences). June 1967. Contract AT(40-1)-2911. 17p. (EE-3930-104-67U). Dep. CFSTI.

Results of measurements of ionization in CO_2, C_2H_4, and C_2H_2 by keV ions of hydrogen, oxygen, and argon are reported. Equipment to be used for measurement of the inelastic energy loss in small-angle ion−atom scattering is described. A method is described for calculating the energy going into kinetic energy of gas atoms for the case of an ion passing through a polyatomic gas. (A.G.W.)

33123 (SC-DC-67-1791) PULSED ELECTRON BEAM CALORIMETRY UTILIZING STRESS WAVE MEASUREMENTS IN SOLID ABSORBERS. Graham, R. A.; Hutchison, R. E.; Benedick, W. B. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 15p. (CONF-670528-1). Dep. CFSTI.

From 9th Annual Symposium on Electron, Ion, and Laser Beam Technology, Berkeley, Calif.

Measurements show that the stress pulses resulting from the absorption of intense pulsed electron beams can be measured in considerable detail. The stress-pulse amplitudes and durations are observed to scale quantitatively with the intensity and energy characteristics of the beams absorbed in various absorbers. The electron-pulse duration is shown as a distinct feature of the stress pulse. It is concluded that measurements of the stress pulses in thick elastic absorbers can provide a basis for calorimetry of pulsed electron beams. Presently, the measurements are limited to relative values that can be calibrated by more conventional means. Computer solutions of the complex elastic wave propagation problem will permit absolute values to be recovered from these same measured pulses. It appears that aluminum and X-cut quartz are the best absorber materials for a calorimeter. Aluminum has a much larger thermoelastic constant than quartz, which gives it a superior signal-to-noise ratio. Thus, aluminum is preferable for absorbed energies less than about 8 cal/gram. However, the elastic constants of aluminum are sensitive to temperature rise, and the temperature-independent properties of X-cut quartz absorbers make quartz a better material for higher-intensity pulses. Present measurements show that the most desirable gage for the stress-pulse measurements is a guard-ring gage 31.8 mm in diameter and 6.35-mm thick with an active center electrode diameter of 12.7 mm. (auth)

33124 (ANL-Trans-495) LUMINESCENCE OF SOME MOLECULAR GASES DURING THE EXCITATION BY FAST ELECTRONS. I. Anton, H. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Ann. Phys. (7), 16: 17-29(1965). 19p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The molecular gases N_2, CO, H_2, D_2 and the mixtures N_2-H_2 and N_2-D_2 are bombarded with ~50-keV electrons. Measurements of the pressure dependence of the decay time of individual bands, intensity measurements, and spectroscopic observations yield clues concerning the most important elementary processes of the excitation and extinction of the luminescence. (auth)

33125 A STUDY OF EMISSIVITIES AND TRANSITION PROBABILITIES OF DIATOMIC MOLECULES IN OPTICALLY THICK HOT GASES WITH APPLICATIONS TO THE $B^1\Sigma-X^1\Sigma$ TRANSITION OF BeO. Drake, G. W. F.; Tyte, D. C.; Nicholls, R. W. (York Univ., Toronto). J. Quant. Spectrosc. Radiative Transfer, 7: 639-59(July-Aug. 1967).

A method is described for the determination of band strengths from intensity measurements of an optically thick band spectrum in which the bands may be strongly overlapped. Synthetic band intensity profiles are calculated and used to obtain both a temperature and a well-defined value of $N_0|R_e(\overline{r}_{v',v''})|^2$ for each band from experimental intensity ratios only. The procedure is applied to the $B^1\Sigma-X^1\Sigma$ transition of BeO excited in a shock tube. The BeO gas phase concentration is estimated by thermodynamic calculations, and the absolute electronic transition moment evaluated. (auth) (UK)

33126 ABSOLUTE OSCILLATOR STRENGTHS FOR ONCE-IONIZED ELEMENTS OF THE IRON GROUP. Warner, B. (Univ. of London Observatory). Mem. Roy. Astron. Soc., 70: 165-253 (1967).

A description is given of a high voltage light source suitable for the excitation of the second spectra of the iron-group elements. Studies show that the plasma is characterized by an excitation temperature of 6,130°K and an electron density about 4×10^{14} cm^{-3}. This source is used to provide line intensities of 2,378 classified lines in the spectra of the once ionized iron-group elements (Sc II−Ni II). In general the wavelength region covered is approximately 3,000 to 5,000 Å, but in the case of Fe II an extension down to 2,500 Å is made. With the aid of alloys of accurately known composition the line intensities are placed on a homogeneous relative scale for all ions. From these intensities relative oscillator strengths were calculated. These relative f values were placed on a best absolute scale by reference to a large number of theoretical f values, computed by means of the Coulomb approximation, making use only of multiplets selected for closeness to LS-coupling requirements. The agreement from ion to ion for observed and calculated f values is good, and the absolute scale is established with a standard error of about ±0.07 dex. The f values for high level lines (upper excitation potential >50 kK) show the unexplained increase with EP (excitation potential) that has been observed in several other light sources. An EP correction function was applied, in order that there should be no dependence on EP of the ratio of observed and calculated oscillator strengths. (auth) (UK)

33127 TOTAL CONTINUOUS ABSORPTION COEFFICIENTS FOR COMPLEX ATOMS. Peach, G. Mem. Roy. Astron. Soc., 71: 29-45(1967).

Continuous absorption coefficients, in which both the bound−free and free−free contributions are included, are calculated for C, N, O, Mg, Mg^+, Si, Cl, and Ca^+. A Boltzmann distribution is assumed for the relative populations of the discrete energy levels, and for the continuum states the absorbing electron has a Maxwell energy distribution. The present results for nitrogen and oxygen give improved agreement with experiment in the spectral region 4300 to 6300 Å as compared with earlier calculations. The agreement with the experimental data for chlorine in the regions 2800 to 5400 Å is less satisfactory. (auth) (UK)

33128 REVISED GENERAL FORMULA FOR THE CALCULATION OF ATOMIC PHOTOIONIZATION CROSS SECTIONS. Peach, G. Mem. Roy. Astron. Soc., 71: 13-27(1967).

Burgess and Seaton, Mon. Notic. Roy. Astron. Soc., 120: 121 (1960) derived a general formula by assuming that the atom may be represented by an electron moving in a central field. The method depends on being able to obtain effective quantum numbers and extrapolated continuum phases from the experimental data on the relevant energy levels. More recently, the Burgess and Seaton

tables have been shown to be in error for levels of high effective quantum number and their calculations are completely revised in this paper. It is shown that in the regions where their integrals were calculated directly there is excellent agreement between the two sets of results for the amplitude and phase factors. Comparisons are made with other results for bound–free transitions for a few illustrative cases. (auth) (UK)

33129 FREE–FREE ABSORPTION COEFFICIENTS FOR NONHYDROGENIC ATOMS. **Peach, G. Mem. Roy. Astron. Soc., 71: 1-11(1967).**

Free–free absorption coefficients are calculated for H, He, He^+, Li, C, N, O, Na, Mg, Mg^+, Al, Si, Cl, K, and Ca^+. In the case of a hydrogenic atomic system the total free–free absorption coefficient may be evaluated exactly, assuming that a Maxwell distribution is valid for the initial energy of the free electron. For all the other atoms considered a correction term is added to the hydrogenic coefficient, which takes account of deviations from the hydrogen-like continuua for low values of the angular momentum l. This correction term is obtained by using the general formula developed by the author for the individual free–free transition cross sections and summing over the relevant values of l. (auth) (UK)

33130 PHOTON SCATTERING CROSS SECTIONS AT LYMAN–α (1215.7 A) FOR He AND Ne. **Shardanand (Massachusetts Inst. of Tech., Cambridge); Mikawa, Y. Contracts NASw-395; NAS-1283. J. Quant. Spectrosc. Radiative Transfer, 7: 605-9(July-Aug. 1967).**

The relative photon scattering cross sections for helium and neon at Lyman–α were measured for the first time by observing right-angle scattering. The technique employed a microwave-powered hydrogen light source with an oxygen filter to isolate the Lyman–α radiation and a highly sensitive NO-filled Geiger counter. Measurements for the relative cross sections were also made for the gases Ar, N_2, and H_2, and were found to agree with similar measurements reported by Gill and Heddle. The results were placed on an absolute basis by utilizing the theoretical He value of 3.5×10^{-26} cm^2 of Chan and Dalgarno. (auth) (UK)

33131 ELECTRON SCATTERING IN THICK TARGETS. **Bishop, H. E. (Cambridge Univ., Eng.). Brit. J. Appl. Phys., 18: 703-15(June 1967).**

A simple Monte Carlo procedure for simulating the scattering of electron beams with incident energies in the range 5 to 40 kev has been developed, based on a screened Rutherford cross section and the Bethe continuous energy-loss equation. Despite the approximate nature of the initial scattering data, the calculations agree well with the available experimental data for the lighter elements. Agreement is not so good for the heavy elements, but it is still possible to obtain a qualitative picture of electron scattering in these elements. (auth) (UK)

33132 SEQUENTIAL MASS SPECTROMETRY: NITROGEN AND THE DETERMINATION OF APPEARANCE POTENTIALS. **Cuthbert, J.; Farren, J.; Rao, B. S. Prahallada (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Phys. Soc. (London), 91: 63-70(May 1967). (AERE-R-5248).**

Electron-impact ionization of N_2 below 70 eV was studied under conditions favorable to the trapping of ions in the electron beam. The ionization of N_2 is observed to produce N_2^+, N_2^{+*}, N_2^{2+}, $N^+ + N(^4S^0)$, $N^+ + N(^2P^0)$, $(N^+ + N?)$, $N^{2+} + N$ and $(N^{2+} + N?)$, where product pairs in parentheses have excess energy distributed in an undetermined manner. Electron collisions with N_2^+ give N^+, N_2^{2+} and $N^{2+} + N$, and collisions with N_2^{2+} give $N^{2+} + N$. The problem of determining appearance potentials under these conditions is discussed, and a new method is presented and applied to the above processes. Comparisons with known or expected appearance potentials show that the error in determining thresholds is 0.37 ± 0.23 eV. (auth) (UK)

33133 ELECTRON ATTACHMENT AND DETACHMENT IN OXYGEN. **Sukhum, N.; Prasad, A. N.; Craggs, J. D. (Univ. of Liverpool). Brit. J. Appl. Phys., 18: 785-92(June 1967).**

New measurements have been made, by the Townsend method, of the α and η coefficients in oxygen to enable the effect of electron detachment (δ) from negative oxygen ions to be studied. It is concluded and δ is negligible compared with η for pressures higher than about 50 torr and for E/p (electric field strength/pressure) <45 V cm^{-1} $torr^{-1}$ (20°C). The Townsend method is capable of demonstrating and giving accurate values of δ, particularly at lower pressures. (auth) (UK)

33134 RESONANCE CHARGE TRANSFER BETWEEN H(1s) AND H^+ CALCULATED BY A PERTURBED STATIONARY-STATE APPROXIMATION INCLUDING IDENTITY EXCHANGE EFFECTS. **Parcell, L. A.; May, R. M. (Univ. of Sydney). Proc. Phys. Soc. (London), 91: 54-8(May 1967).**

The perturbed stationary-state approximation is used to calculate the cross section for charge transfer between H^+ ions and atomic hydrogen at ion energies between 1 eV and 10 keV, with the proper inclusion of exchange effects due to the identity of the protons. The resulting values diverge at low energies from previous theoretical calculations, and lie above the experimental measurements. (auth) (UK)

33135 A RELATIVISTIC HARTREE–FOCK ATOMIC FIELD CALCULATION. **Coulthard, M. A. (Univ. of Melbourne). Proc. Phys. Soc. (London), 91: 44-9(May 1967).**

Relativistic Hartree–Fock self-consistent fields have been obtained for a number of atoms by solving numerically the equations given by Grant [Proc. Roy. Soc., A, 262: 555-76 (1961)], but with the magnetic interaction terms and off-diagonal Lagrange parameters omitted. The results are discussed briefly, with those for Hg being considered in more detail. The off-diagonal parameters are included in some simple cases and their effect is shown to be relatively small. The binding energies for several inner atomic electrons are calculated and compared with experiment. (auth) (UK)

33136 $Z^{-1/2}$ EXPANSION OF THE UNRESTRICTED HARTREE-FOCK EQUATIONS FOR THE (1s)(1s′) ^1S STATES OF HELIUM AND HELIUM-LIKE IONS. **Coulson, C. A.; Hibbert, A. (Oxford Univ.). Proc. Phys. Soc. (London), 91: 33-43(May 1967).**

An equation is derived for the first of the half-order terms, $u_{1/2}$, in the $Z^{-1/2}$ expansion of the orbital wave functions for the (1s)(1s′) ^1S ground state of helium and helium-like ions. This equation is solved by expanding $u_{1/2}$ in a series of generalized Laguerre polynomials; two cases are considered, in which 12 and 30 terms, respectively, are taken in the series. The effect of $u_{1/2}$ on the second- and third-order energy coefficients E_2 and E_3 is studied. It is shown that the inclusion of $u_{1/2}$ accounts for 92% of the Z-independent term in the series expansion of the radial correlation energy, and that considerable improvement is made on the restricted Hartree–Fock value of E_3. (auth) (UK)

33137 INCOHERENT SCATTERING OF 320-keV PHOTONS BY K-SHELL ELECTRONS. **Reddy, A. Ramalinga; Lakshiminarayana, V.; Jnanananda, S. (Andhra Univ., Waltair, India). Proc. Phys. Soc. (London), 91: 71-5(May 1967).**

The differential incoherent scattering cross sections of 320-keV photons by K-shell electrons of lead, tantalum, and samarium were experimentally determined employing a fast–slow coincidence scintillation spectrometer by the degraded photon K x-ray coincidence technique at angles of scattering 45°, 60°, 90°, and 110°. The results are compared with the computed values, and the trends of the incoherent scattering function are discussed. (auth) (UK)

33138 POLARIZATION OF ALKALI ATOM RESONANCE LINES EXCITED BY ELECTRON IMPACT. **Flower, D. R.; Seaton, M. J. (London Univ.). Proc. Phys. Soc. (London), 91: 59-62(May 1967).**

The threshold polarizations of the resonance lines of ^6Li, ^7Li, and ^{23}Na, excited by electron impact, are calculated using the theory theory of Percival and Seaton [Phil. Trans. Roy. Soc. London, Ser. A, 251: 113-38(1958)]. The results obtained are in good agreement with measured values of Hafner, Kleinpoppen, and Krüger [Phys. Letters, 18: 270-1 (1965)]. (auth) (UK)

33139 COMPUTER PROGRAMMES FOR HIGH-RESOLUTION NMR. CALCULATION OF DOUBLE RESONANCE SPECTRA. **Govil, G.; Whiffen, D. H. (National Physical Lab., Teddington, Eng.). Mol. Phys., 12: 449-56(1967).**

The theory of nuclear magnetic double resonance has been developed for machine adaptation and a computer programme based on it has been written. The application of this programme is illustrated. (auth) (UK)

33140 NEW MEASUREMENTS OF THE THERMAL VELOCITY DISTRIBUTIONS IN ELECTRON BEAMS. **Beck, A. H.; Maloney, C. E. (Cambridge Univ., Eng.). Brit. J. Appl. Phys., 18: 845-7(June 1967).**

The design of an electron velocity analyzer, based on an electrostatic einzellinse which incorporates a fine mesh in the centre electrode, is described. Measurements made on a low-energy electron beam show no sign of any broadening of the emission velocity spectrum, i.e., of the so-called "Boersch effect." (auth) (UK)

33141 PRINCIPLE OF THE INVARIANCE OF BRIGHTNESS IN ELECTRON OPTICS. **Spanner, D. C. (London Univ.). Brit. J. Appl. Phys., 18: 773-6(June 1967).**

The principle that (excluding irreversible effects) the brightness (or the current per unit area per unit solid angle) of an electron beam is invariant over any equipotential region of space is established by simple considerations based on classical thermodynam-

ics, and its value confirmed as $\beta = (\rho_c/\pi)[1 + (e\phi/kT)]$ where ρ_c is the cathode emission and ϕ the accelerating potential. The principle is paralleled by a well-known optical principle which, however, is rather more broadly based. Both apply to small solid angles. (auth)

33142 AVERAGE ENERGY EXPENDITURE PER ION PAIR FOR 0.8-MeV CARBON AND NITROGEN RECOILS. Carter, Bridget J. (Middlesex Hospital Medical School; London). Phys. Med. Biol., 12: 321-31(July 1967).

The average energy expenditure per ion pair for carbon and nitrogen recoils (W_r) was compared with that for ^{238}Pu alpha particles (W_α). The pulse heights of the recoil and alpha particles were compared in a proportional counter, the recoils being produced by the interaction of 2.9-MeV neutrons with the gas in the counter. The ratio of W_r to W_α was found to be between 1.2 and 1.3 for carbon recoils in carbon dioxide, ethylene, methane, and tissue-equivalent gas, and to be 1.2 for nitrogen recoils in nitrogen gas. (auth) (UK)

33143 THE He–He POTENTIAL ENERGY IN THE REGION OF THE VAN DER WAALS MINIMUM. Murrell, J. N.; Shaw, G. (Univ. of Sussex, Brighton, Eng.). Mol. Phys., 12: 475-80(1967).

The energy of interaction of two helium atoms near their van der Waals minimum has been calculated using a perturbation expansion. An SCF wave function is used to calculate the first-order energy and the second-order (dispersion) energy is taken from previous work. An energy minimum of -3.3×10^{-5} a.u. at a separation of 5.5 a.u. is obtained, in good agreement with experimental results. (auth) (UK)

33144 ELECTRON CAPTURE BY 33- AND 38-MeV PROTONS IN GASES. Acerbi, E.; Castiglioni, M.; Dutto, G.; Resmini, F.; Succi, C.; Tagliaferri, G. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Nuovo Cim. (10), 50B: 176-8(July 11, 1967).

Electron capture cross sections were measured for 38 and 33-MeV protons in N_2, O_2, and argon. The measurements were carried out to test the adequacy of different theoretical approaches for cross sections at energies beyond 10 MeV, and comparisons are made with the earlier calculations. (M.O.W.)

33145 ACCURATE FITTING OF REALISTIC INTERATOMIC POTENTIAL. Dueren, R.; Schlier, Ch. (Univ., Freiburg i. B.). J. Chem. Phys., 46: 4535-6(June 1, 1967).

A procedure for fitting atomic-collision data utilizes a χ^2 minimum method and the four-parameter potential ($V^* = V/\epsilon$, $x = r/r_m$): $V^*(x) = f(x) - [f(x) + 1]C \exp[-(x-1)^2/\beta^2]$. This potential modifies the (12,6) potential $f(x) = x^{-12} - 2x^{-6}$ so as to flatten the bottom of the well by a variable amount and width. The procedure was used to fit all existing measurements of the intermolecular potential of K–Ar; results are given. (A.G.W.)

33146 MEASUREMENT OF EXCITATION AND IONIZATION IN AN ARC-HEATED SUPERSONIC ARGON BEAM. Winicur, Daniel H.; Knuth, Eldon L. (Univ. of California, Los Angeles). J. Chem. Phys., 46: 4318-20(June 1, 1967).

Measured values of fractional excitation and fractional ionization are reported for a 1.52-eV argon beam extracted from an arc-heated supersonic free jet. The data indicate that the ions are molecular during at least a portion of the free-jet expansion, that nearly all of the ions are neutralized during this expansion, and that most of the excited particles formed as a consequence of this neutralization are long-lived. (auth)

33147 MEASUREMENT OF THE Li–Hg TOTAL CROSS SECTION AT VERY LOW ENERGIES. Rothe, Erhard W.; Helbing, Reinhard K. B. (General Dynamics/Convair, San Diego, Calif.). J. Chem. Phys., 46: 4549-50(June 1, 1967).

The ^{7}Li–Hg system was used to observe resonance effects in atom–atom total scattering cross sections at relative velocities of <1000 m/sec. A previously reported unusual low-energy behavior of Q(v) was not observed; a normal $Q \propto v^{-1/3}$ behavior was found. Possible reasons for the discrepancy are suggested. (A.G.W.)

33148 ROTATIONAL AND VIBRATIONAL ENERGY LEVEL DISTRIBUTION OF N_2^+ IONS PRODUCED IN COLLISIONS BETWEEN ELECTRONS AND NITROGEN MOLECULES. Polyakova, G. N.; Fogel, Ya. M.; Zats, A. V. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz., 52: 1495-1503(June 1967). (In Russian).

The intensity distribution of the rotational lines of the λ 4278 Å (0,1) band of the first negative system of the N_2^+ (1 ns N_2^+) ion is investigated. The 1 ns N_2^+ bands were excited by impact of 25 to 600 eV electrons traversing a chamber filled with nitrogen at a pressure of 2×10^{-3} mm Hg. When the spectrum is excited by electrons with energies exceeding 100 eV the intensity distribution of the rotational lines of the λ 4278 Å band can be described by the Boltzmann formula. Deviations from the Boltzmann formula are observed at energies below 100 eV, the degree of deviation increasing with decrease of the electron energy. The relative intensities of the 1 ns N_2^+ bands at 3884 Å (1,1), 3914 Å (0,0), 4236 Å (1,2), 4278 Å (0,1), 4652 Å (1,3), and 4709 Å (0,2) are measured. The relative population of the first vibrational level of the $B^2\Sigma_u^+$ state of the N_2^+ ion is calculated for various electron energies on basis of the measured relative band intensities. Excitation by electrons with energies below 100 eV leads to a value for the population which deviates from that computed on basis of the Franck–Condon principle. A correlation is observed between the deviation of the intensity distribution in the rotational structure of the band from the Boltzmann distribution and the degree of deviation of the relative population of the first vibrational level computed on the basis of the Franck–Condon principle. (auth)

33149 SCREENING IN THE ATOMIC PHOTOEFFECT. Gorshkov, V. G.; Mikhailov, A. I.; Polikanov, V. S. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 52: 1570-8(June 1967). (In Russian).

The effect of screening on the photoeffect from the K shell is taken into account in the first approximation in perturbation theory. As a basis the expansion of the relativistic Coulomb functions in aZ is employed. It is shown that screening lowers the cross section by several percent. (auth)

33150 CONTRIBUTION TO THE THEORY OF SPONTANEOUS EMISSION FROM ATOMS IN AN EXTERNAL FIELD. Notkin, G. E.; Rautian, S. G.; Feoktistov, A. A. (Moscow Physical-Technical Inst.). Zh. Eksp. Teor. Fiz., 52: 1673-87(June 1967). (In Russian).

The quantum theory of spontaneous emission from atoms located in an external electromagnetic field is developed. The external field may be treated classically as well by quantum mechanics. The general formulas for the probability of spontaneous emission are considered in detail for the resonance approximation. The line shape for a monochromatic external field and large Doppler broadening is analyzed. The external field results in deformation of the line contour. This can be interpreted as being due to (1) a change in the velocity distribution of the atoms and (2) interference effects by mixing of stationary states of the isolated atom by the external field. Under some conditions the second factor completely counterbalances the effect of the first factor. (auth)

33151 APPLICATION OF THE QUASICLASSICAL METHOD TO INCOHERENT NEUTRON SCATTERING BY MOLECULES. Summerfield, G. C.; Zweifel, P. F. (Univ. of Michigan, Ann Arbor). Phys. Rev., 159: 1-2(July 5, 1967).

The quasiclassical theory of neutron scattering is applied to the free rotations of a molecule. The cross section is expressed in terms of solutions to the classical equations of motion. It is seen that if a short-collision-time approximation is applied to this result, the so-called Krieger–Nelkin approximation is obtained. (auth)

33152 RESONANCE BROADENING OF ABSORPTION LINES. Bezzerides, Bandel (Univ. of California, Livermore). Contract W-7405-eng-48. Phys. Rev., 159: 3-10(July 5, 1967). (UCRL-70001).

A general theory of line broadening is used to study the effects of collisions on absorption line shapes when self-broadening is important. Special attention is focused on the role of processes in which an excited atom transfers its electronic excitation to an unexcited atom; it is this process that distinguishes self-broadening from foreign-gas broadening. Several forms for the absorption rate are presented corresponding to particular assumptions about the amplitudes associated with this phenomenon. For example, one approximation leads to a generalized Lorentz–Lorenz law in which the one-atom polarizability is replaced by one that accounts for line broadening. Finally, the importance of many-body effects in the calculation of the linewidth is briefly discussed to determine when simple impact theories are applicable. (auth)

33153 INELASTIC COLLISIONS BETWEEN EXCITED ALKALI ATOMS AND MOLECULES. II. THE QUENCHING OF SODIUM RESONANCE RADIATION BY N_2, H_2, HD, AND D_2. Kibble, B. P.; Copley, G.; Krause, L. (Univ. of Windsor, Canada). Phys. Rev., 159: 11-13(July 5, 1967).

The cross sections for quenching collisions between excited sodium atoms and N_2, H_2, HD, and D_2 molecules in their electronic ground states have been determined using a delayed-coincidence method. The sodium atoms in mixtures with the gases were excited with 20-nsec pulses of NaD radiation, and the delays between the exciting and fluorescent pulses were measured with a time-to-pulse-height converter. The resulting pulse-height spectra, accumulated in a 400-channel kicksorter, yielded the effective lifetimes τ' of the sodium resonance state, which are shorter than the

natural lifetime τ because of the nonradiative decay induced in collisions with the molecules. The cross sections for collisions with N_2, H_2, HD, and D_2, obtained from an analysis of the dependence of τ' on the gas pressures, are 30.4 ± 1.2, 16.2 ± 0.3, 11.6 ± 0.4, and 9.8 ± 0.3 Å^2, respectively. (auth)

33154 ELASTIC SCATTERING OF LITHIUM IONS IN HELIUM AND HYDROGEN. Zehr, F. J.; Berry, H. W. (Syracuse Univ., N. Y.). Phys. Rev., 159: 13-20(July 5, 1967).

The cross sections for elastic scattering of 50- to 800-eV Li^+ ions in He and in H_2 have been measured using a method in which the energy-loss spectrum of the ions is observed as a function of the scattering path length. The experimental procedure yields directly the cross section for scattering outside a given angle, which ranges from 10 to 160° in the center-of-mass system. From these data, the interaction potential was computed by a process that involves the numerical integration of the inverted orbit equation for a series of constant angular momenta. The potential so found may be represented by the Born–Mayer form within a few percent as $V(r) = 3.7 \times 10^2\ e^{-5.1r}$ eV for Li^+–He and $3.0 \times 10^2\ e^{-11.0r}$ eV for Li^+–H_2, with r in Å. The V(r) for Li^+–He has also been calculated using the two-center Thomas–Fermi–Dirac statistical model, yielding reasonably good agreement with the experimental result. (auth)

33155 ELECTRON-IMPACT IONIZATION MEASUREMENTS OF SURFACE-IONIZABLE ATOMS. McFarland, Robert H. (Univ. of California, Livermore). Phys. Rev., 159: 20-6(July 5, 1967). (UCRL-70248).

Total electron-impact ionization cross-section measurements are presented for calcium, strontium, barium, and thallium. These and previously determined cross sections for the alkali metals are compared with available techniques for calculating cross sections. Because of the difficulty of both the experimental measurements and the calculations, it is perhaps surprising to find agreement generally better than a factor of 2. (auth)

33156 STOCHASTIC METHOD FOR CALCULATING WAVE FUNCTIONS. Kostin, M. D.; Steiglitz, K. (Princeton Univ., N. J.). Phys. Rev., 159: 27-30(July 5, 1967).

A relationship between the Boltzmann transport equation for a point in 3n-dimensional configuration space executing random motion and the Schrödinger wave equation for n electrons is investigated. It is shown that wave functions and related quantities for the ground and excited states of atomic systems may be calculated with a stochastic computer program by incorporating the Pauli exclusion principle into the stochastic formalism. Stochastic calculations are presented for the ground state of hydrogen and for the ^1S and ^3S states of helium. (auth)

33157 CORRESPONDENCE PRINCIPLE IN INELASTIC SCATTERING. Garcia, J. D. (Univ. of Pittsburgh). Phys. Rev., 159: 39-41(July 5, 1967).

Ionization of hydrogen by electrons is examined for the case of high incident-electron energies. The Born quantum cross section is found to approach the classical expression in the limit of large principal quantum numbers. The energy dependence of the cross section at high energy is discussed; it is expected that the cross sections go smoothly from (lnE/E) to 1/E behavior as n becomes large. (auth)

33158 POLARIZATION OF SLOW ELECTRONS BY Hg AND RANGE OF APPLICABILITY OF THE RELATIVISTIC HARTREE POTENTIAL. Eitel, W.; Jost, K.; Kessler, J. (Technische Hochschule, Karlsruhe, Ger.). Phys. Rev., 159: 47-9(July 5, 1967).

New measurements on the angular and energy dependence of the polarization of slow electrons scattered by mercury atoms are reported. Special attention is paid to electron energies below 500 eV where, according to a recent paper of Schonfelder, derivations from the present theories should be expected, since at small energies the use of the static Hartree potential for treating the scattering process should no longer be a good approximation. Since the measurements were made with an angular resolution of ±1°, a direct comparison with the theoretical results was feasible. Absence of plural scattering was carefully checked. The discrepancies between theory and experiment reported by Schonfelder did not appear, and the theoretical results proved reliable down to 100 eV, the lowest energy for which numerical evaluations of the present theories were available. A survey of the work done so far on electron polarization by scattering from mercury atoms indicates sound knowledge of the polarization effect for energies between 100 and 2000 eV and scattering angles from 30° to 150°. (auth)

33159 ATOMIC PHOTOEFFECT IN THE RANGE E_γ = 1 TO 2000 keV. Rakavy, G.; Ron, A. (Hebrew Univ., Jerusalem). Phys. Rev., 159: 50-6(July 5, 1967).

Photoelectric cross sections are presented for photon energies in the range 1 to 2000 keV. The atomic wave functions have been evaluated using Shalitin's modified Fermi–Amaldi potential, except for uranium, for which the Thomas–Fermi potential is used. The results are probably accurate to a few percent. (auth)

33160 TWO-DETERMINANT SPIN-POLARIZED CALCULATION OF THE HYPERFINE STRUCTURE OF ^{11}B. Kerwin, J. (St. John's Univ., Jamaica, N. Y.); Burke, E. A. Phys. Rev., 159: 57-60(July 5, 1967).

A two-determinant spin-polarized function derivable from the spin configurations $\Pi_i(\alpha\beta)_i\Pi_j\alpha_j$ and $\Pi_i(\beta\alpha)_i\Pi_j\alpha_j$ is presented and applied to the boron atom using modified Slater orbitals solved non-self-consistently. For purposes of comparison, single-determinant polarized and nonpolarized functions with the same orbital base are also determined. For all three functions the hyperfine constant is calculated, and it is found that the constant α_s [equal to 0.11 atomic units (a.u.) experimentally] changes from −49.96 to −40.33 a.u. from the one- to the two-determinant spin-polarized functions with the corresponding energy improvement from −24.503 to −24.527 a.u. (as compared to the experimental energy of −24.66 a.u. and the best spin-polarized Hartree–Fock value of −24.529 a.u.). In addition it is pointed out that cancellation difficulties in determining charge density at the nucleus from ns pairs is greatly alleviated, and that use of a proper eigenfunction of S^2 requires inclusion of many more determinants than can presently be dealt with. (auth)

33161 ANGULAR DISTRIBUTION OF SINGLE-QUANTUM ANNIHILATION RADIATION. Johnson, W. R. (Univ. of Notre Dame, Ind.). Contract AT(11-1)-427. Phys. Rev., 159: 61-8 (July 5, 1967). (COO-427-60).

Angular distributions of radiation accompanying single-quantum annihilation of positrons by K-shell electrons are calculated. These angular distributions differ from the corresponding Born-approximation calculations, both in magnitude and in shape. For transversely polarized positrons the radiation exhibits an azimuthal asymmetry. The asymmetry, together with the spin-independent part of the differential cross section, is presented for various elements ranging from Z = 47 to Z = 92. Because of the relatively large magnitude of the asymmetry for high-Z targets, it is suggested that detection of the radiation caused by positrons, transversely polarized by an electrostatic analyzer, could provide an alternative means for measuring the longitudinal polarization of positrons emitted in nuclear β decay. Total cross sections obtained by numerically integrating the angular distributions agree precisely with a previous total-cross-section calculation and serve as a measure of the accuracy of the present results. (auth)

33162 HELIUM NEGATIVE IONS FROM METASTABLE HELIUM ATOMS. Donnally, Bailey L.; Thoeming, George (Lake Forest Coll., Ill.). Phys. Rev., 159: 87-90(July 5, 1967).

Helium negative ions were produced from He^+ by a two-step process in which He $(1s2s)^3S_1$ was first produced by a nearly resonant charge transfer and then He^- was produced by capture of a 2p electron. Both collisions were with cesium atoms. The maximum yield of He^- was 1.2% of the incident He^+ when the energy of the He^+ was 3 keV. The cross sections relevant to these processes were obtained. (auth)

33163 THEORY OF REARRANGEMENT COLLISIONS AND RESONANCES. Hahn, Yukap (Univ. of Connecticut, Storrs). Phys. Rev., 159: 91-7(July 5, 1967).

The theory of rearrangement collisions is examined in terms of the channel-projection method, and the singularities in the wave functions are analyzed in detail. Ambiguities in the coupled equations are pointed out, which are the direct consequences of the nonuniqueness in the multicomponent wave functions. Boundary conditions on the wave functions play a crucial role in determining the boundedness of the closed-channel operators. A convenient set of equations whose solutions describe the resonances is derived, and an explicit variational procedure is given to calculate the resonance energies. The method used in deriving the different equivalent sets of coupled equations in terms of the channel-mixing operator is based on the multidimensional formulation of the reaction theory and is quite general. Nonorthogonality of the rearrangement channels allows essentially such arbitrariness, and this can be used to simplify the theory. (auth)

33164 SURFACE IONIZATION OF SOME RARE EARTH ELEMENTS ON HOT POLYCRYSTALLINE TUNGSTEN SURFACE. Dey, S. D.; Karmohapatro, S. B. (Saha Inst. of Nuclear Physics, Calcutta). J. Phys. Soc. Jap., 23: 418-21(Aug. 1967).

The surface ionization of the rare earth elements Gd, Ho, Dy, Pr and Er has been studied for very low electric field (<3 KV/cm) at the surface and the ionization potentials (I.P.) of these elements have been measured. The values of ionization potentials are:

Gd- 6.73 ± 0.09 eV, Ho- 6.08 ± 0.09 eV, Dy- 5.72 ± 0.10 eV, Pr- 5.61 ± 0.11 eV and Er- 6.36 ± 0.10 eV. A reasonable agreement of these values with the spectroscopically determined ones suggest that the degree of ionization follows the general form of the Saha-Langmuir equation. The measurements, carried out with rare earth chloride molecular beams on the polycrystalline surface, indicate that (1) complete dissociation of the rare earth halides occur for surface temperatures at ~2000°K, (2) above 2000°K the surface remains free of adsorbed chlorine and (3) the variations of the ratios of the statistical weight factors of the ions and atoms with temperature are small. (auth)

33165 ON THE THEORY OF ELECTRON–ATOM COLLISIONS. Gomberoff, L. (University Coll., London). Nuovo Cim. (10), 50B: 169-72(July 11, 1967).

Results are reported after introduction of quantum field-theoretical methods into the theory of electron–atom collisions, using Feynman's formalism. (M.O.W.)

33166 ELECTRON–ELECTRON SCATTERING AT ENERGY OF 2 X 135 MeV. Budker, G. I.; Kushnirenko, E. A.; Naumov, A. A.; Onuchin, A. P.; Popov, S. G.; Sidorov, V. A.; Skrinskii, A. N.; Tumaikin, G. M. At. Energ. (USSR), 22: 164-8(Mar. 1967). (In Russian).

On the counter electron beam of the VEP-1 storage ring, the angular distribution of the scattering of electron on electron was measured at angles from 40 to 90° at an energy of 2 × 135 MeV. The measurements were carried out by means of a system of spark chambers with photographic reporting. The experimental results confirmed the validity of the laws of quantum electrodynamics down to intervals of 0.6 Fermi. (tr-auth)

33167 DOUBLE BREMSSTRAHLUNG EMISSION IN ELECTRON–ELECTRON COLLISIONS AT ENERGY OF 2 X 160 MeV. Golubnichii, P. I.; Onuchin, A. P.; Popov, S. G.; Sidorov, V. A. At. Energ. (USSR), 22: 168-73(Mar. 1967). (In Russian).

The process of double bremsstrahlung in scattering of electrons on electrons was investigated on the counter electron beam of the VEP-1 storage ring. The measurements were made at 3 electron energies: 2 × 43, 2 × 135, and 2 × 160 MeV. Two absorption counters with NaI(Tl) crystals were used in the experiments. The total cross section of the process obtained and the energy distribution of the γ quanta agree with the theoretical results of Bayer and Galitsky. (tr-auth)

33168 SOURCE OF POLARIZED IONS. Slabospitskii, R. P.; Karnaukhov, I. M.; Ekhichev, O. I.; Taranov, A. Ya. (Physical-Technical Inst., Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 2031-6(Dec. 1966). (In Russian).

A source of polarized ions capable of producing a 0.3 μA beam of polarized deuterons with a polarization tensor component P_{33} of −0.274 is described. The source can also be employed to produce a beam of polarized protons. In this source the electron spin components in a beam of deuterium atoms are separated in an inhomogeneous magnetic field and the resulting beam of atoms with aligned electron spins is ionized by electron impact. Owing to the coupling between the electron and nuclear spins in the atom, there results a partially polarized beam of deuterons. In the described device deuterium molecules were admitted through a palladium filter to a Pyrex vessel coated on the inside with $(CH_3)_2SiCl_2$ where they were dissociated by the 150-MHz field produced by a 1.5-kW oscillator. The deuterium atoms issued from the dissociation vessel through a microcollimator of glass capillaries and traversed the field of a magnetic quadrupole which focused the component of the beam having the electron spins parallel to the direction of motion and defocused the component having antiparallel electron spins. The polarized atomic beam then traversed the ionizer where the atoms were ionized by impact of electrons moving in the same direction as the atomic beam. The polarized deuteron beam was subsequently accelerated to the desired energy. The ionizer was shielded from fringe fields by a soft steel jacket, and a uniform axial magnetic field was produced within it by a pair of Helmholtz coils. The thermionic cathode and the electron accelerator, focusing, and collector electrodes of the ionizer had central openings for passage of the atomic beam. (ATD)

33169 NEUTRALIZATION OF PROTONS TRAVERSING THIN METAL FOILS. Yavlinskii, Yu. N.; Trubnikov, B. A.; Elesin, V. F. (Inst. of Atomic Energy, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1917-20(Dec. 1966). (In Russian).

A theoretical explanation is given of the experimental results of J. A. Phillips (Phys. Rev., 97: 404 (1955)), who measured the relative numbers of hydrogen atoms and negative ions in approximately 30 to 200 keV proton beams after the beams had traversed metal foils. Phillips' experiments showed that the relative number of atoms and negative ions in the beam was independent of the thickness of the foil and was determined by the last few atomic layers. After a brief discussion it is concluded that "tunnel" recombination cannot have been significant, and it is hypothesized that the recombination took place by triple collisions in the surface layer where the electron density is enhanced by the effect of the electron pressure in the body of the metal. The triple recombination coefficient is calculated in terms of the mobility with the aid of the classical theory of Langevin. The mobility is calculated for two limiting cases of low and high proton velocity, and there result two formulas for the recombination probability as a function of the proton energy, one of which is valid at low energies, and one, at high energies. The experiments were performed at proton energies for which neither of the formulas is valid; the experimental curve lies between the two rather widely separated theoretical curves, however, and this is regarded as qualitative confirmation of the theory. (ATD)

33170 RELATIVISTIC SLATER'S INTEGRALS FOR THE K AND L SHELLS. Asaad, W. N. (Univ., Muenster, Ger.). Z. Phys., 203: 362-71(1967).

The Z-dependent form of the Slater's integrals for electrons in the K and L shells is studied by expanding the relativistic hydrogenic radial wave functions in the manner explained by Layzer and Bahcall. When screening is not taken into consideration, these Slater's integrals can be put in the form $AZ(1 + aZ^2)$ where a is positive for all integrals considered except $G^1(1s,2p)$ and $G^2(2\bar{p},2p)$. Values of A and a are given. (auth)

33171 DIFFUSE REFLECTION AND TRANSMISSION BY UNIFORM NONCOHERENTLY SCATTERING MEDIA. Black, R. B. T. (Univ. of Sydney). Austral. J. Phys., 20: 271-82 (June 1967).

Diffusely reflected and transmitted spectral line profiles are calculated for uniform noncoherently scattering media onto which radiation of frequency near that of a resonance line of the medium is incident. Profiles are calculated for incident light that is either collimated or uniformly diffused and that is either monochromatic, or of uniform frequency distribution, or contains an absorption line centered on the resonance line under discussion. Spectral lines generated by uniformly excited media are also calculated. (auth)

33172 ANGULAR DISTRIBUTION OF ATOMS SPUTTERED FROM MONOCRYSTALLINE GOLD. Chapman, G. E.; Kelly, J. C. (Univ. of New South Wales, Kensington). Austral. J. Phys., 20: 283-9(June 1967).

The angular distribution of atoms sputtered from metal single crystals has been used to study atom ejection processes. By analyzing this distribution into the sum of a Gaussian and a cosine contribution it is shown that the isotropic background can be removed and considerably improved agreement obtained between theory and experiment. This is applied to the temperature variation of the width of Wehner spots. New experimental results are presented for gold sputtered by 10-keV argon ions over a wide range of temperatures. (auth)

33173 SPUTTERING EXPERIMENTS WITH 1- TO 5-keV Ar^+ IONS. II. MONOCRYSTALLINE TARGETS OF Al, Cu, AND Au. Robinson, Mark T.; Southern, A. L. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 38: 2969-73(June 1967). (ORNL-P-2826).

Sputtering yields have been measured during normally incident 1- to 5-keV Ar^+ ion irradiation of polycrystalline Au, ⟨100⟩, ⟨110⟩, and ⟨111⟩ Au monocrystals, a ⟨111⟩ Al monocrystal, and several ⟨0kl⟩ Cu monocrystals of previously unreported orientations. Onderdelinden's transparency model is found to account satisfactorily for the orientation dependence of the yields of low-index Cu, Au, and Ge crystals. The importance of the recording geometry in governing the appearance of sputtering ejection patterns is demonstrated. The so-called ⟨114⟩ ejection-pattern spots from ⟨111⟩ fcc crystals are attributed to assisted focusing sequences along ⟨100⟩, the most probable ejection direction being shifted because the last focusing "lens" is incomplete. (auth)

33174 MASS-SPECTROMETRIC STUDY OF SPUTTERING OF SINGLE CRYSTALS OF GaAs BY LOW-ENERGY Ar IONS. Comas, James; Cooper, C. Burleigh (Univ. of Delaware, Newark). J. Appl. Phys., 38: 2956-60(June 1967).

Single crystals of GaAs [(110), (111), and $(\bar{1}\bar{1}\bar{1})$ faces] were sputtered by normally incident low-energy (0 to 140 eV) argon ions in the source of a mass spectrometer. For each face, approximately 99.4% of the collected ions were neutral Ga and As atomic species; the balance were neutral GaAs molecules. No neutral Ga_2, As_2 or $(GaAs)_2$ molecules, or negative Ga^-, As^-, or $(GaAs)^-$ ions, with the characteristics of sputtered particles, were detected. Sputtering "yields" for the three faces were found to be: "Y" (111) ≈ "Y" $(\bar{1}\bar{1}\bar{1})$ > "Y" (110). (auth)

33175 DYNAMIC FOCUSING OF ELECTRONS IN A TWO-DIMENSIONAL DEFLECTION. Wang, C. C. T. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Appl. Phys., 38: 3038-40(June 1967).

The focusing effects responsible for the aberrations of astigmatism and curvature of the magnetic field were studied for a magnetically deflected electron-beam system in which the undeflected beam is focused to a point in the center of the target. (M.O.W.)

33176 ELECTRON SPIN POLARIZATION DUE TO A MAGNETIC IMPURITY. Fullenbaum, Martin S.; Falk, David S. (Univ. of Maryland, College Park). Phys. Rev., 157: 452-6 (May 10, 1967).

The Green's function for an electron gas interacting with a localized moment through the s−d contact interaction, in the presence of a magnetic field, is found to second order in perturbation theory. The moment is polarized, giving an electron spin polarization as a function of distance from the impurity. It is shown that spin-flip terms in second order give a correction to the Ruderman−Kittel−Yosida spin polarization. This correction is proportional to $\ln k_F r$ times an oscillatory function of $k_F r$ at large distances from the moment. For completeness, the susceptibility of the system is computed. (auth)

33177 DIRECT COMPARISON OF THE PENETRATION OF SOLIDS AND LIQUIDS BY POSITRONS AND ELECTRONS. Takhar, P. S. (Royal Military Coll. of Canada, Kingston). Phys. Rev., 157: 257-61(May 10, 1967).

A new experimental technique has been used to investigate the penetration of 1.88-MeV positrons and 1.77-MeV electrons in carbon, aluminum, copper, tin, lead, brass, Teflon, Plaskon, Lumarth, water, benzene, and toluene. These are the first such measurements for liquids. The results, which measure transmissions down to 2%, indicate greater transmission of positrons than electrons in solids and liquids, except in brass and Plaskon. The difference in transmission is 12% for Al, 35% for Pb, and 88% for toluene. The greater transmissions in aluminum and lead are in qualitative agreement with the scattering theory; however, there is at present no theoretical explanation for the measured differences in the rest of the solids and the liquids. (auth)

33178 EVIDENCE AGAINST FOCUSED CHAINS IN HIGH-YIELD COPPER SPUTTERING. Olson, N. Thomas; Smith, Harold P. Jr. (Univ. of California, Berkeley). Phys. Rev., 157: 241-5(May 10, 1967).

The yield (atoms/ion) and angular distribution (atoms/ion sr) of monocrystalline copper sputtered by 1- to 10-keV cesium ions have been measured as a function of target temperature at normal and at 45° incidence to the (100) face. The yield as a function of energy and at normal incidence attained a broad maximum of 6.2 atoms/ion in the neighborhood of 5 keV and was independent of target temperature variation from 77 to 493°K. At nonnormal incidence, the sputtering yield was markedly affected by the opacity of the target lattice to the incident ion beam, as is demonstrated by a higher yield for incidence along the [755] direction when compared with the [110] direction. The fitting of an analytic function to the extensive angular emission data by nonlinear regression analysis indicated that preferred emission along the close-packed direction was of secondary importance, decreasing from 18% at 1 keV to 10% at 10 keV. The primary contribution to the sputtering distribution followed a polar angle cosine dependence. (auth)

33179 SPALLATION YIELD OF XENON FROM 730-MeV PROTON IRRADIATION OF BARIUM. Funk, H.; Rowe, M. W. (Univ. of California, Berkeley). Earth Planet. Sci. Lett., 2: 215-19(May 1967).

The isotopic composition of xenon produced by 730-MeV proton bombardment of $BaCl_2$ was measured to be: $^{124}Xe : {}^{126}Xe : {}^{127}Xe : {}^{128}Xe : {}^{129}Xe : {}^{130}Xe : {}^{131}Xe : {}^{132}Xe : {}^{134}Xe$ corresponding to 72 : ≡ 100 : 102 : 116 : 111 : 72 : 183 : 52 : 4.6, respectively. The cross section observed for ^{126}Xe production was 0.140 barn. The agreement between these measured yields and the yields calculated by means of the spallation systematics of Rudstam is in general quite good: striking discrepancies occur, however, at ^{130}Xe and ^{132}Xe. These findings confirm the relative yield found from meteoritic spallation xenon which shows similar discrepancies at ^{130}Xe and ^{132}Xe. The discrepancy at ^{129}Xe between the meteoritic data reported by Rowe and spallation systematics is not confirmed in this work. (auth)

33180 SPECTRAL DENSITY OF HYDROGEN IN WATER. Haywood, B. C. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy, 21: 249-62(Mar. 1967).

A method is described in which the spectral density for the motions of hydrogen in H_2O at room temperature is derived. An iterative procedure is used, starting from measured partial differential neutron cross section measurements. Raman and infrared data are used in regions where the neutron data are poor or nonexistent. The total neutron scattering cross section for water as a function of energy is calculated, and shown to agree with experiment. (auth) (UK)

33181 LABORATORY MEASUREMENT OF THE RATE CONSTANT FOR $H^- + H \rightarrow H_2 + e$. Schmeltekopf, A. L.; Fehsenfeld, F. C.; Ferguson, E. E. (Aeronomy Environmental Science Services Administration, Boulder, Colo.). Astrophys. J., 148: L155-6(June 1967).

The first laboratory measurements of rate constants for associative detachment reactions of the type $X^- + Y \rightarrow XY + e$ have recently been carried out. Because of its astrophysical implication, the reaction $H^- + H \rightarrow H_2 + e$ was studied and a rate constant of 1.3×10^{-9} cm^3/sec was found. The rate constant is believed to be reliable to within a factor of 2. The measurements were made in a fast-flowing afterglow system. The H^- ions were produced by the dissociative attachment process $NH_3 + e \rightarrow H^- + NH_2$, the electrons being produced from a hot filament with energies up to 100 eV. The H atoms were produced by discharging H_2 with a microwave discharge. (W.D.M.)

33182 THRESHOLD BEHAVIOR OF ELECTRON EXCITATION AND POLARIZATION FUNCTIONS IN HELIUM. Heddle, D. W. O.; Keesing, R. G. W. (Univ. Coll., London). Proc. Roy. Soc. (London), Ser. A, 299: 212-20(June 14, 1967).

The apparent discrepancy between many previous measurements of polarization and the theoretical predictions at threshold is discussed briefly. The problems of measurement are outlined, and a data-logging system which enables long-integration times to be combined with a rapid coverage of a suitable range of electron energy, is described. The experimental results show that light from the 4^1D-2^1P, 3^1P-2^1S, and 3^3P-2^3S transitions is polarized to an extent compatible with the theoretical threshold predictions, but that the polarization falls rapidly above threshold. The polarization remains finite as the electron energy is reduced. Light from the 4^3S-2^3P transition is unpolarized at all energies. (auth) (UK)

33183 EFFECT OF FLUCTUATIONS OF THE INTERNAL MAGNETIC FIELD ON MOESSBAUER SPECTRA. Pal, L. (Central Research Inst. of Physics, Budapest). Acta Phys. Acad. Sci. Hung., 23: 161-83(1967). (In Russian).

The effect of directional fluctuations of the internal magnetic field on the shape of Mössbauer spectra has been investigated. It has been found that for increasing frequency of fluctuations first the lines of hyperfine splitting broaden, then shift and finally merge into a central line narrowing gradually as the frequency continues to increase. The disappearance of the splitting takes place when the frequency ω_R of the fluctuations exceeds the Larmor frequency ω_L of the lines involved. At the instant of coalescence the central line exhibits a substantial deviation from the Lorentzian shape. The position and width of each line as well as the mechanism of coalescence are appreciably affected by an external magnetic field. (auth)

33184 PRESSURE DISSOCIATION AND HIGH-DENSITY ADIABATS. Vardya, M. S. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). Mon. Notic. Roy. Astron. Soc., 133: 145-9(1966).

The effect of pressure dissociation on high-density adiabats was investigated. It was found that it may make a substantial difference at higher densities, as compared to when the pressure effect is neglected in the thermodynamic functions for hydrogen molecule and hydrogen molecular ion. (auth)

33185 DEPOSITION OF ATOMS SPUTTERED IN AN ABNORMAL GLOW DISCHARGE. Mase, H.; Nakaya, S.; Hatta, Y. (Tohoku Univ., Sendai). J. Appl. Phys., 38: 2960-2(June 1967).

Using an optical-transmission method, the deposition of sputtered Ni atoms on a glass collector in an abnormal glow discharge is measured in Ar and Ar−H_2 mixture at 5 torr. The distribution of atoms deposited on a glass collector is found to be determined by the diffusion process of sputtered atoms in the gases. The results show that the sputtering rate is proportional to the square of the current, and the sputtering rate of 100% Ar is about twice as large as that of 70% Ar−30% H_2 mixture. (auth)

33186 ANNIHILATION OF POSITRONS IN ALUMINUM, RHODIUM, AND SILVER. Chen, Tuan-wu; Ma, Ing-jiunn; Chien, Ji-peng (National Tsing Hua Univ., Taiwan, China). Chin. J. Phys. (Taiwan), 5: 31-2(Apr. 1967).

The dynamic behavior of electrons was studied, using annihilation of positrons in aluminum, rhodium, and silver. The linear momentum distribution of the participating electrons was determined, using the angular distribution of annihilated gamma rays. (M.O.W.)

33187 ENERGY AND ANGULAR DISTRIBUTIONS OF SECONDARY ION EMISSION. I. EXPERIMENTAL APPARATUS.

Hennequin, Jean-Francois (Faculte des Sciences, Orsay, France). Rev. Phys. Appl., Suppl. J. Phys., 1: 273-81(Dec. 1966). (In French).

An experimental study was made of secondary ion emission, and in particular of the distribution in energy and angle of secondary ions emitted during the bombardment of a sample by primary ions having an energy of a few keV. The apparatus and its principles of operation are described here. (auth)

33188 EXTRACTION MECHANISM IN POSITIVE ION SOURCES WITH HIGH-FREQUENCY ELECTRIC EXCITATION. INFLUENCE OF AUXILIARY LONGITUDINAL MAGNETIC INDUCTION. Vacquie, Serge; Bacri, Jean; Benoit-Cattin, Pierre; Blanc, Daniel; Dagnac, Rene; Faye, Henri (Faculte des Sciences, Toulouse). Rev. Phys. Appl., Suppl. J. Phys., 1: 282-6(Dec. 1966). (In French).

Thonemann-type sources, with inductive coupling, are studied. With a movable probe, it is possible to make measurements of the divergence angle and of the ionic density of the extracted beam, as a function of the various parameters of the source. A coaxial magnetic induction very much decreases the angular divergence of the beam, and increases the density of the extracted current, if its value is correctly chosen. (auth)

33189 TEMPERATURE DEPENDENCE OF THE ISOMER SHIFT AND THE HYPERFINE FIELD NEAR THE CURIE POINT IN IRON. Preston, Richard S. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Rev. Lett., 19: 75-7 (July 10, 1967).

Mössbauer measurements were made on ^{57}Fe in iron near the Curie temperature. The discontinuity in the isomer shift near T_c is found to take place within a temperature range of less than 0.3°C, which suggests that this magnetic transition could be of first order. The "critical index" β for the variation with temperature of the spontaneous magnetization in the range $0.98\ T_c < T < 0.9992\ T_c$ is found to be definitely greater than $\frac{1}{3}$. (auth)

33190 MEASUREMENTS OF DISSOCIATIVE RECOMBINATION OF CO_2^+ IONS WITH ELECTRONS. Weller, Charles S.; Biondi, Manfred A. (Univ. of Pittsburgh). Phys. Rev. Lett., 19: 59-61(July 10, 1967).

A microwave-afterglow differentially pumped quadrupole mass spectrometer was used to study the dependence of the predicted ionospheric electron density on the value of the dissociative recombination coefficient $\alpha(CO_2^+)$ between electrons and CO_2^+ ions. (TSS)

33191 RECALCULATION OF EXPERIMENTAL AND COMPUTED DATA FROM 600 kV PULSED X-RAYS. Tochilin, E.; Goldstein, N. (Naval Radiological Defense Lab., San Francisco). Health Phys., 13: 809(July 1967).

The authors have discovered an erroneous comparison in their paper "Dose rate and spectral measurements from pulsed x-ray generators" (Health Phys., 12: 1705(1966)). A spectrum obtained by means of film analysis for pulsed x rays from a 600-kV Fexitron flash x-ray unit was compared to x-ray spectra obtained with a spectrometer at a Van de Graaff accelerator with bombarding electrons of 550-kV energy and a target simulating the flash unit. Unfortunately, the film analysis spectrum was assumed to be a differential x-ray spectrum. When the curve was replotted in the appropriate units the agreement was quite apparent. (auth)

33192 DETERMINATION OF THE MEAN CLUSTER SIZE AND THE RESIDUAL GAS PORTION OF CONDENSED MOLECULAR BEAMS BY SCATTERING OF POTASSIUM ATOM BEAMS. Burghoff, H.; Gspann, J. (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Z. Naturforsch., 22a: 684-9(May 1967). (In German).

The mean size of the clusters in a condensed nitrogen molecular beam is evaluated from the attenuation of a potassium atomic beam crossing the nitrogen beam at right angles. The method is based on the fact that molecules in a cluster will shield each other and therefore contribute the less in the scattering processes the larger the cluster is. The percentage of unclustered molecules in the condensed beam is determined by measuring the decrease of the potassium beam attenuation resulting from filtering the condensed nitrogen beam with a scattering chamber. Assuming a spherical drop as a model for the clusters the average number of molecules per cluster can be estimated from the measured effective cross sections. It increases from 160 to 6500 when the nitrogen source pressure is increased from 100 to 700 mm Hg. At the same time the percentage of single molecules in the original condensed beams decreases from 30% to 0.15% of the total beam intensity. (auth)

33193 APPROXIMATE MOLECULAR ORBITALS. III. THE $1s\sigma$ AND $2p\pi$ STATES OF HeH^{++}. Cohen, M.; McEachran, R. P.; McPhee, Sheila D. (York Univ., Toronto). Can. J. Phys., 45: 2231-8(July 1967).

A combination of Rayleigh-Schroedinger perturbation theory and variational techniques, previously used to calculate the wave functions of the lowest σ and π states of H_2^+ has been applied to the $1s\sigma$ and $2p\pi$ states of HeH^{++}. The accuracy of the resulting approximate wave functions is demonstrated by comparing a number of quantities calculated with them with the corresponding exact values. (auth)

33194 IONIZATION OF Ar ATOMS IN THE Ar^+ EXCITED STATE. Vainshtein, L. A.; Vinogradov, A. V. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 5: 269-72(May 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 328-31(May 1, 1967).

The ionization of an Ar atom with simultaneous excitation of Ar^+ was studied by investigating electron-atom collision processes in which the states of two atomic electrons are changed. (M.O.W.)

33195 STRUCTURE CORRECTIONS TO THE HYPERFINE SPLITTING OF THE HYDROGEN ATOM. Guerin, F. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim. (10), 50A: 211-36(July 21, 1967).

The influence of the proton structure on the hyperfine splitting appears in the exchange of two high-momentum photons between the electron and the proton. The contribution of the intermediate states involving π mesons together with the proton are evaluated: the π-nucleon S wave is found to contribute to 1 ppm, and all the known π-nucleon resonances to a smaller than 1 ppm. The exchange of an 1^+ meson between the electron and the proton is studied by means of two graphs; the effect is found to be 0.1 ppm. One concludes that, in the present state of our knowledge, the effects of the proton structure cannot be blamed for the discrepancy between the theoretical and experimental hyperfine splitting. (auth)

33196 ENERGY LOSSES OF 6 keV ELECTRONS IN A TWO-LAYERED BERYLLIUM-GOLD TARGET. Nakhodkin, N. G.; Mel'nik, P. V.; Kryn'ko, Yu. M. (Kiev State Univ.). Ukr. Fiz. Zh., 12: 509-11(Mar. 1967). (In Russian).

It has been shown that the average energy loss per unit of pathlength for high electron energies is given by Bethe's formula: $-dE/dx = (A/E) \ln (1.16\ E/I)$. Here A is a coefficient depending only on the substance, and I is the average excitation potential of the scattering material, which is determined empirically. Thin beryllium films which are transparent to low-energy electrons were prepared by condensation in a high vacuum on a gold backing. Electrons inelastically reflected from a gold backing have an energy close to the initial energy. The energy spectra of the inelastically scattered 6-keV electrons from various thicknesses of beryllium metal were determined. The electrons reflected from gold were faster than those reflected from beryllium. The average energy loss was found to be 0.8 V/Å, which agreed well with a value of 0.73 V/Å calculated from Bethe's formula. Two-layered targets can be used to estimate the electron energy loss per unit of pathlength in light substances. (TTT)

33197 CURRENT OPERATORS AND MAJORANA EQUATION FOR THE HYDROGEN ATOM FROM DYNAMICAL GROUPS. Barut, A. O.; Kleinert, Hagen (Univ. of Colorado, Boulder). Phys. Rev., 157: 1180-3(May 25, 1967).

It is proved that the dipole operator in the hydrogen atom is the product of an element in the Lie algebra and of a group element of the conformal group O(4,2). A relativistic wave equation containing the total momentum only is set up which describes the internal structure of the system purely group theoretically and gives the correct mass spectrum. The diagonalization of this equation determines a new basis of states in which the dipole operator is simply an element of the Lie algebra. The angle of transformation to the new basis is evaluated to be $\theta = 2 \tanh^{-1}(1 - \epsilon/n)$, or, $\theta = \log(2n/\epsilon)$, where n is the principal quantum number and ϵ is essentially the fine-structure constant. (auth)

33198 VACANCY CASCADE IN THE REORGANIZATION OF KRYPTON IONIZED IN AN INNER SHELL. Krause, Manfred O.; Carlson, Thomas A. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 158: 18-24(June 5, 1967). (ORNL-P-2697).

Charge distributions of krypton ions following ionization in the 1s, 2s, or 2p shell are calculated under the assumption that reorganization occurs by successive steps in a vacancy cascade in which Auger and radiative transitions partake. These distributions compare favorably with experimental charge spectra arising from photo-ionization in the K or L shell, from electron capture in ^{79}Kr, and from β decay in ^{85}Kr (Snell and Pleasonton's earlier work). If the electron-shakeoff process is also incorporated in the calculation, good agreement with experiment is achieved. Possible applications of the vacancy-cascade model are briefly discussed for other modes of inner-shell ionization and for molecular and

solid-state systems. Probabilities of electron shakeoff from any shell of krypton are calculated for photo-ionization in the 1s, 2s, or 2p shell, for β^+ and β^- decay, and for Auger processes 1s-2p2p, 2p-3p3p, and 2p-3d3d. (auth)

33199 ISOTOPE EFFECT IN THE DISSOCIATIVE ATTACHMENT IN H_2 AT LOW ENERGY. Schulz, G. J.; Asundi, R. K. (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 158: 25-9(June 5, 1967).

The dissociative attachment cross section for formation of H^- and D^- from H_2, HD, and D_2 has been measured in the threshold range from 3.75 to 5 eV using a mass spectrometer for ion identification. A pronounced isotope effect is observed. The cross section of H^- from H_2 has a peak value of 1.6×10^{-21} cm^2; D^- from HD, 1×10^{-22} cm^2; and D^- from D_2, 8×10^{-24} cm^2; all peaks occurring at 3.75 eV. Negative-ion fromation in this energy range proceeds via the compound state $^2\Sigma_u^+$ whose lifetime against autodetachment is calculated from the above cross sections to be about 1×10^{-15} sec. Because of this short lifetime and the relatively long time needed for the atoms to separate, the probability of survival of the negative ion, and therefore the dissociative attachment cross section in H_2 at 3.75 eV, is small. For the heavier isotopes, the separation time is even longer and therefore the dissociative attachment cross section is minute. The same compound state is also responsible for vibrational excitation of the hydrogen molecule. (auth)

33200 LYMAN-α RADIATION RESULTING FROM ION COLLISIONS WITH MOLECULAR GASES. Van Zyl, Bert; Jaecks, Duane, Pretzer, Donavon; Geballe, Ronald (Univ. of Washington, Seattle). Phys. Rev., 158: 29-33(June 5, 1967).

Cross sections for the emission of Lyman-α radiation resulting from ion–target-gas collisions have been measured for projectile energies between 1 and 25 keV. All combinations of H^+, D^+, H_2^+, D_2^+, and He^+ projectiles on H_2 and D_2 targets as well as H^+ and H_2^+ on N_2 have been studied. Although product excited H or D atoms which decay via the 2p-1s Lyman-α-emitting transition may result from a variety of collision mechanisms, some interpretation has been possible using data from earlier experiments. (auth)

33201 ATOMIC MANY-BODY PROBLEM. III. THE CALCULATION OF HYLLERAAS-TYPE CORRELATED WAVE FUNCTIONS FOR THE BERYLLIUM ATOM. Szasz, Levente; Byrne, John (Fordham Univ., New York). Phys. Rev., 158: 34-48 (June 5, 1967).

By applying the theory of correlated wave functions, Hylleraas-type functions are computed for the beryllium atom. The theory is applied in a form in which only two-electron correlations are considered. Several different correlation factors as well as several different combinations of orbital functions are considered. It is shown that the Hylleraas method gives better results for the energy than the superposition of configurations in the 1s shell as well as in the 2s shell. The problem of the additivity of the correlation energy in pairs is analyzed and it is shown that the sum of pair-correlation energies is different from the correlation energy computed taking into account correlation in both shells simultaneously. The difference can be positive or negative depending on the wave functions, and it is not negligible if accurate values are required for the correlation energy. Comparing the computed values for the correlation energy resulting from two-electron correlations with the experimental value of the correlation energy, the size of the many-electron (more than two-electron) correlation effects is estimated. It is shown that these effects can not be neglected if accurate values are required for the correlation energy. (auth)

33202 VELOCITY DISTRIBUTION OF METASTABLE H ATOMS PRODUCED BY DISSOCIATIVE EXCITATION OF H_2. Leventhal, M.; Robiscoe, R. T.; Lea, K. R. (Yale Univ., New Haven). Phys. Rev., 158: 49-56(June 5, 1967).

The velocity spectrum of metastable H(2S) atoms produced by electron bombardment of H_2 has been measured by a time-of-flight technique. Two distinct groups of metastables have been detected. The slower atoms are interpreted as arising from transitions to attractive states just above the H(1S) + H(2S) dissociation limit. The faster atoms are thought to arise from transitions to doubly excited repulsive states which have not previously been detected. (auth)

33203 DISSOCIATIVE IONIZATION OF H_2 AND D_2. Kieffer, L. J.; Dunn, Gordon H. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). Phys. Rev., 158: 61-5(June 5, 1967).

Energy distributions of H^+ (D^+) from dissociative ionization of H_2 (D_2) are reported. Evidence of the $2p\sigma_u$ state's being the major source of energetic ions is cited. Calculated and measured energy distributions do not agree well. Possible explanations are suggested. (auth)

33204 INELASTIC COLLISIONS OF THE SECOND KIND BETWEEN ELECTRONS AND EXCITED MERCURY ATOMS. Burrow, P. D. (Univ. of California, Berkeley). Phys. Rev., 158: 65-9(June 5, 1967).

The relative cross section for inelastic collisions of the second kind between electrons and mercury atoms in the excited $^3P_1$ state was measured as a function of electron energy. Excited atoms were produced by absorption of the 2537 Å resonance line from a mercury arc. A low-energy beam of electrons was produced using a retarding potential difference method. Scattered electrons which gained kinetic energy were detected by passing them through a potential barrier which reflected unscattered electrons. The data are in good agreement with the cross section computed by applying detailed balancing to the known cross section for excitation to the $^3P_1$ state by electron impact. Information about the angular scattering dependence was also obtained. (auth)

33205 CROSS SECTIONS FOR ELECTRON CAPTURE BY FAST PROTONS IN H_2, He, N_2, AND Ar. Welsh, Leland M.; Berkner, Klaus H.; Kaplan, Selig N.; Pyle, Robert V. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 158: 85-92(June 5, 1967). (UCRL-16765(Rev.)).

Cross sections for electron capture by protons have been measured at energies from 440 keV to 13.8 MeV in N_2 and in Ar; to 5.41 MeV in He; and to 2.45 MeV in H_2. Electron-loss cross sections in the same gases at 1.027 and 2.44 MeV are also presented. The measurements were carried out by analysis of particle-beam composition after exit from a gas target of known composition and thickness. The beam was separated magnetically, and the charged and neutral components were detected by a Faraday cup and a scintillator, respectively. The energy range of the results overlaps that of Barnett and Reynolds between 440 keV and 1 MeV. The electron-capture cross sections in this region agree within the experimental uncertainty for H_2 and He, but are larger by up to 50% in N_2 and Ar. (auth)

33206 HYPERFINE SEPARATION OF TRITIUM. Mathur, B. S.; Crampton, S. B.; Kleppner, D.; Ramsey, N. F. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 158: 14-17(June 5, 1967).

The hyperfine separation of tritium has been measured with respect to the hyperfine separation of hydrogen by comparing the frequency of the tritium maser with that of a hydrogen maser. The result is $\Delta\nu(T) = 1{,}516{,}701{,}470.8087 \pm 0.0071$ Hz, where it is assumed that $\Delta\nu(H) = 1{,}420{,}405{,}751.8$ Hz. Wall shifts were measured for tritium and hydrogen for FEP Teflon at 35°C. For a spherical bulb, d cm in diameter, the fractional wall shift for hydrogen is $-(3.61 \pm 0.54) \times 10^{-10}/d$, and for tritium it is $-(3.14 \pm 0.47) \times 10^{-10}/d$. (auth)

33207 DECAY OF EXCITED SPECIES IN A PULSED DISCHARGE IN KRYPTON. Turner, R. (National Research Council, Ottawa). Phys. Rev., 158: 121-9(June 5, 1967).

The emission in the afterglow of a pulsed discharge in krypton has been investigated. Measurements of the decay times of the resonance radiation at λ1236 Å and a diffuse molecular radiation at λ1250 Å and longer wavelengths have been made as functions of pressure at 295 and 196°K. The measurements have been interpreted on the assumption of a simple two-time-constant model, leading to values of the collision frequencies for collision-induced transitions between the metastable level ($1s_5$) and the resonance level ($1s_4$) of 13×10^{-14} cm^3/sec and 22×10^{-14} cm^3/sec at 295 and 196°K, respectively, for de-exciting collisions ($1s_4 - 1s_5$), and 7.6×10^{-16} cm^3/sec and 1.3×10^{-15} cm^3/sec, respectively, for exciting collisions ($1s_5 - 1s_4$). The coefficients for the conversion of metastable atoms to molecules in two- and three-body collisions with normal atoms has also been determined. The two-body collision frequency for molecule formation was found to be 15×10^{-16} cm^3/sec and 26×10^{-16} cm^3/sec at 295 and 196°K, respectively, and the three-body collision frequency was found to be 4×10^{-32} cm^6/sec and 6.9×10^{-32} cm^6/sec at 295 and 196°K. The results are compared with existing measurements in other rare gases. The two-body part of the molecule formation is discussed in terms of an interatomic potential which has a hump similar to that proposed in the case of helium. (auth)

33208 PROCEEDINGS OF THE SECOND OXFORD ELECTRONICS LECTURE COURSE, 1966: ADVANCED ELECTRONIC TECHNIQUES. Dummer, G.W.A. (ed.). Sponsored by "Electronic Components" and "Instrument Practice". London, United Trade Press Ltd., 142p. 70s.

The following two lectures are included: Ion Beam Implantation by L. N. Large (Services Electronics Research Laboratory), and Thermionic Power Generation by L. G. Sanders (Atomic Energy Research Establishment, Harwell). (UK)

33209 METHOD OF POLARIZING IONS, PARTICULARLY PROTONS AND DEUTERONS, APPLICABLE TO SOURCES OF POLARIZED IONS. Abragam, A.; Beurtey, R.; Papineau, A.;

Thirion, J.; Winter, J. M. (to CEA). Canadian Patent 755,210. Mar. 21, 1967. Priority date July 28, 1962, France.

An apparatus is described for polarizing the atoms in an atomic jet of hydrogen or deuterium and then separating the jet into two streams according to their electron spin. Magnetic dipolar transitions are induced by adiabatic passage in a weak field. A second magnetic field causes the variation in the internal energy to be a linear function of the field from zero to the average value of all permissible quantum states of electron and nuclear spins. (F.S.A.)

33210 ELECTRON-ATOM COLLISIONS WITH POLARIZATION AND EXCHANGE EFFECTS INCLUDED. Gingo, Peter Joseph. Los Angeles, Univ. of California, 1966. 149p.

Thesis.

A variational method is derived by which the elastic scattering cross sections for electron–atom collisions are calculated. The method includes the effects of the atomic polarization and electron exchange induced by the incident electrons. The variational method was applied to the s-wave hydrogen–electron scattering and oxygen–electron scattering problems. The calculated cross section for the hydrogen–electron scattering deviated very slightly from the results of Seaton, which are considered to be very reliable. With the proposed method, various quantities such as the electron polarizabilities and the contributions of a few excited states also have been included. The incident energy of the incident electron was varied from 0.01 to 0.7 atomic units (Rydberg) (one atomic unit = 13.60 eV). This variational method was then applied to the oxygen–electron scattering with the incident electron energy ranging from 0.02 to 0.7 atomic units. These calculations were made with the hydrogen-like orbital wave functions for the oxygen as given by R. G. Breen, Jr. and also with Hartree–Fock tabulated orbital wave functions. The cross sections calculated appeared to reproduce the results of Bates and Massey and some experimental results much more than other current results presented. A general review is given in which some general methods are presented by which the hydrogen–electron scattering cross sections as well as atomic-electron scattering cross sections have been calculated. (Disser. Abstr.)

33211 ENERGY AND OTHER PROPERTIES OF H_3^+. Pearson, Angus George. Austin, Univ. of Texas, 1966. 74p.

Thesis.

With an eighteen-term wave function, using 16 generalized Gaussian orbitals as a basis, a minimum energy of –1.3185 a.u. was found for H_3^+ in an equilateral triangular configuration having sides 1.66 bohr. With a twelve-term wave function having six Gaussian orbitals as a basis, the A_1' normal mode of vibration was found to have $\omega_0 = 2887\ cm^{-1}$. Contours of constant electron density are given. Energy contours are presented for molecular perimeters of 4.95 and 19.8 bohr. (Disser. Abstr.)

33212 ON THE HYPERFINE STRUCTURE OF THE MOLECULES H_2^+, HD^+, AND D_2^+. Williams, Neville Allen Jr. Berkeley, Calif., Univ. of California, 1966. 100p.

Thesis.

The spin-dependent hyperfine structure of each of the molecular ions H_2^+, HD^+, and D_2^+ in the ground electronic state is examined. It is shown that in the zeroth rotational state, the hyperfine structure of these molecules is completely calculable within the context of the Born–Oppenheimer approximation procedure. In particular, the hyperfine structure of D_2^+ in the ground electronic state and zeroth rotational state is calculated for the first nine nuclear vibrational states using an IBM 7090 computer. The calculation is based on the electron wave functions and electron energy tabulated by Bates et al., for the ground state of these molecules. The first nine vibrational wave functions for D_2^+ are numerically determined and used in the hyperfine structure calculation. An ion beam method for observing the radio-frequency spectrum of D_2^+ in the zeroth rotational state is proposed and the design of a spectrometer, which was constructed and tested, is described in detail. In the experiment, a beam of neutral D_2 molecules in the lowest vibrational and, primarily, in zeroth rotational state is first aligned using a hexapole focusing magnet and then ionized by electron bombardment preserving the nuclear spin projection. The D_2^+ ions are accelerated to form an ion beam, which passes through an rf region in which transitions can be induced that alter the alignment. The beam is then accelerated to 300 keV and allowed to strike a tritium target from which neutrons are emitted with spin-dependent angular anisotropy in the reaction $T(d,n)^4He$. It is demonstrated that ion currents can be realized, which made detection of hyperfine structure transitions in the ion beam by counting neutrons practical. It is shown that the hyperfine structure in a number of vibrational states can be extracted from these observations. It is possible to adapt the spectrometer so that observations can be made on HD^+ as well. (Disser. Abstr.) (TSS)

33213 POSITRON ANNIHILATION IN SOLID AND LIQUID METALS AND SEMICONDUCTORS. Kusmiss, John Henry. Chapel Hill, N. C., Univ. of North Carolina, 1966. 137p.

Thesis.

The angular correlation of the photon pairs emitted when positrons annihilate in solid and liquid Al, Sb, Bi, Cd, Ga, In, K, Pb, Li, Hg, Se, Te, Tl, Sn, and Zn has been measured. Experiments were performed for each material at room temperature and at temperatures just above and below the melting point. Experiments have also been performed on Mg and Ge at room temperature and at another temperature higher than room temperature but still below the melting point. In addition the metals Ba, Ca, and Sr have been studied at room temperature with better counting statistics and the metal Y with better angular resolution than has previously been reported. Results are presented in the form of experimentally determined angular correlation curves and also in the form of slope distributions derived from the angular correlation data. For each element studied in both the solid and liquid phases the apparent fractions of annihilations taking place with conduction and with core electrons were determined by fitting a Gaussian to the large-angle points and a free-electron parabola to the central points of the angular correlation distribution. Phenomenological two-parameter fits to the slope distributions were also obtained, taking the angular resolution of the experimental apparatus into account. The elements investigated have been classified into three categories according to how the angular correlation curve changes when the element is heated or melted. Large changes in the angular correlation distribution were found for several metals at temperatures below the melting point. No difference in the angular correlation curves for Mg and Ge was observed in heating the specimens from room temperature to 420°C and 650°C, respectively. The angular correlation distribution for the metal Y was found to be narrower than the free-electron parabola corresponding to three valence electrons per atom. (Disser. Abstr.)

33214 THE INTERACTION OF HEAVY IONS WITH M-SHELL ELECTRONS. Khandelwal, Govind Sharan. Chapel Hill, N. C., Univ. of North Carolina, 1966. 36p.

Thesis.

The calculation of the cross section for the removal of an inner-shell atomic electron by bombardment with protons or other heavy ions is extended to the M shell. The Bethe-Born approximation was applied to calculation of an M-shell form factor, which is useful in expressing the ionization cross section and the stopping number for heavy charged particles. The atomic electrons were described by hydrogenic wave functions, and their use is probably the chief weakness of the work. The algebraic labor involved was relegated to the computer, which was also used for some of the numerical work in obtaining as final results the stopping power as a function of energy of three representative values of an atomic screening parameter. The M-shell results are compared with similar results known previously for the K and L shells. The possibility of extending such calculations to higher atomic shells, using more realistic wave functions, is indicated. (TSS) (Disser. Abstr.)

33215 ELECTROMAGNETIC SCATTERING OF CHARGED PARTICLES WITH SPIN. Holdeman, Jonas Tillman Jr. Cleveland, Case Inst. of Tech., 1966. 120p.

Thesis.

The effect of the anomalous magnetic moment of charged particles in electromagnetic scattering is studied. The Coulomb interaction is treated exactly, while the phase shift due to the interaction of the magnetic moment with the Coulomb field is treated in the distorted wave Born approximation. These phase shifts are found from the Schrödinger equation with relativistic corrections and from the Dirac equation with a Pauli moment interaction. The expressions for the two scattering amplitudes in terms of the phase shifts are examined. For several cases these amplitudes are calculated numerically, along with the electromagnetic polarization. The results are compared with other approximations. (Disser. Abstr.)

Cosmic Radiation

Refer also to abstracts 32369, 32423, 32431, 33280, 33719, 33954, and 33963.

33216 (AD-637557) HEAVY PARTICLES IN THE PRIMARY COSMIC RADIATION. Final Scientific Report. VonFriesen, S. (Lund Univ. (Sweden). Dept. of Physics). May 26, 1966. Contract AF-EOAR-35-64. 15p. (AFOSR-66-1712). CFSTI.

The investigations were mainly concentrated on studies of the composition of the radiation with special emphasis on the relative frequency of the heavy nuclei. (TAB)

33217 (BMwF-FBK-67-29) DAS MUONEN-SPEKTRUM UND DAS LADUNGSVERHAELTNIS AUF MEERESHOEHE UNTER EINEM ZENITWINKEL VON 45°. (The Sea-Level Muon Spectrum

and Charge Ratio at a Zenith Angle of 45°). Andresen, R. D. (Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik). Apr. 1967. 26p. (In German). Dep.

The momentum distribution and charge ratio of the penetrating component of the cosmic radiation at sea level have been determined over the range 0.2 to 20 GeV/c at a zenith angle of 45° in the eastern and western azimuths. For these measurements a magnetic spectrograph has been used, based on spark chamber technique for track location. (auth)

33218 (BMwF-FBK-67-30) EIN PROGRAMM ZUR BERECHNUNG ENERGIEREICHER ELEKTROMAGNETISCHER KASKADEN IN LUFTSCHAUERN. (A Program for Computing High Energy Electromagnetic Cascades in Extensive Air Showers). Schlegel, K. E. (Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik). Apr. 1967. 25p. (In German). Dep.

A program for the calculation of high-energy electromagnetic cascades in extensive air showers is described. This Fortran Program is based on the theory of electromagnetic cascades by Nishimura and Kamata. Another Fortran Program FTLS for the calculation of high energy nuclear active particles in extensive air showers is used. Special consideration is given to the calculation of electromagnetic subcores, which may be detected by neonhodoscope pictures. Preliminary results are presented. (auth)

33219 (INR-788/VI/PH) ANALYSIS OF AZIMUTHAL ANGULAR DISTRIBUTIONS OF SECONDARIES FROM INTERACTIONS OF COSMIC RAY PARTICLES WITH EMULSION NUCLEI. Czachowska, Z.; Jurak, A.; Linscheid, A. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 16p. Dep.

Azimuthal angular distributions of 65 events of interactions of cosmic particles with emulsion nuclei have been studied from the viewpoint of noncolinear emission of fireballs. Significant deviation from isotropic distribution of azimuthal angles has been found in the group of events with $\gamma_c \leq 20$ (where γ_c is the Castagnolli estimate of the Lorentz factor of the cms). No such deviation was found for events with $\gamma_c > 20$. (auth)

33220 (INR-803/VI/PH) THE EVALUATION OF THE HEIGHT OF EFFECTIVE MUON PRODUCTION LEVEL IN EAS BY MEANS OF ATTENUATION MEASUREMENTS. Firkowski, R.; Wdowczyk, J.; Zawadzki, A. (Inst. of Nuclear Research, Warsaw (Poland)). 1967. 14p. Dep.

The upper limit of the muon effective production height is evaluated by measurement of the barometric effect of the EAS muonic component and on the basis of the determination of the muon density spectrum exponent γ_μ. Both values were obtained using a recording of about 140,000 showers of the mean size of about 2×10^6. The following results were obtained: for the EAS muon barometric effect, $\beta_\mu = (5.2 \pm 0.7)$ % per 1 cm Hg; for the mean free path of muon absorption, $\lambda = 690$ g/cm^2; and $\gamma_\mu = 2.09 \pm 0.02$. Analysis of the data obtained indicates that the upper limit of the effective production level is $h_\mu = (10 \pm 3)$ km. (auth)

33221 (INR-804/VI/PH) THE FLUCTUATIONS IN THE LONGITUDINAL AND LATERAL DEVELOPMENT OF E.A.S. AND THEIR INFLUENCE UPON THE SPECTRUM OF THE RATIO OF THE MUON TO ELECTRON COMPONENT DENSITY. Gawin, J.; Hibner, J.; Maze, R.; Wdowczyk, J.; Zawadzki, A. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 18p. Dep.

The fluctuations of the μ component due to the longitudinal and lateral development of the EAS were found experimentally in an indirect way. The value of their standard deviation, $\sigma = 0.34 \pm 0.05$, seems to be in a good agreement with a calculated theoretical one ($\sigma = 0.30$). The apparently small value of σ can be satisfactorily explained on the basis of a strong negative correlation between the mean muonic radius $\bar{r}_\mu$ and the EAS size N_e at constant total energy E_o. This negative correlation is suggested in the quoted theoretical work. It leads to a positive correlation between Δ_μ and Δ_e when measured in the central part of a shower of constant size. The decreasing of the $\sigma(\Delta_\mu/\Delta_e)$ as compared to the $\sigma(\Delta_\mu/\Delta_e) = 0.51$ results from the compensation due to the mentioned positive $\Delta_\mu - \Delta_e$ correlation. (auth)

33222 (N-66-30885) RAYONS COSMIQUES ET RAYONNEMENT SYNCHROTRON. (Cosmic Rays and Synchrotron Radiation). Lequeux, J. (Observatoire de Paris-Meudon (France)). Mar. 1966. 55p. (In French). (ESRO-SM-54). CFSTI.

After recalling the chief properties of synchrotron radiation, all the discrete radio sources now known which emit by synchrotron radiation and, hence, are also quite probably sources of cosmic rays, are reviewed. Acceleration, injection, and propagation of cosmic radiation are dealt with. The two main acceleration processes are the betatron process and the Fermi process. Their effect, combined with the effects of losses and leaks, determines the energy spectra. Propagation is studied with the help of two models: lines of force and inhomogeneities. Losses occurring during propagation and fragmentation due to collision and creation of secondary electrons are discussed. Experimental results clearly show the preponderance of the light elements and yield quantitative information on the quantitative composition of the electronic radiation. It is concluded that in order to know the origin of cosmic-ray electrons we ought to: (a) improve the galactic model, (b) measure the e^+e^- ratio, and (c) measure the electron spectrum in the 0.25-GeV range, so as to compare it to the spectrum radiation. (STAR)

33223 (N-67-13117) HIGH ENERGY PRIMARY ELECTRONS AND THE UNIVERSAL BLACK BODY RADIATION. Verma, Satya Dev (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies). Nov. 1966. Contract NSG-179-61. 11p. (NASA-CR-80438; EFINS-66-108). CFSTI.

It is shown that in the framework of the galactic halo model, recent measurements of the electron energy spectrum in the 1- to 350-GeV energy interval are compatible with the presence of universal black body radiation (~3.5°K). The lifetime of the halo electrons is estimated to be $(1.5 \sim 3) \times 10^{15}$ sec. (STAR)

33224 RADIATION DOSE DUE TO COSMIC RAYS. Barnaby, C. F.; Stockel, C. (Medical Research Council, London). Nature (London), 215: 180-1(July 8, 1967).

The principal components of the cosmic-ray dose to populations at sea level are μ mesons and electron–photon cascade showers, the μ-meson dose being the larger. For energies above about 300 MeV the average loss by collision processes in a plastic phosphor is virtually constant at about 1.7 MeV/g cm^2. The cosmic-ray integrated intensity for μ mesons at sea level (lat. 50°N) is 1.01 particles/cm^2/min., of which at least 95% have energies above 300 MeV. The dose due to μ mesons in plastic is therefore 15 mrads/yr., and tissue dose is not significantly different from dose in plastic at sea level. The contribution of the electron–photon showers is more difficult to estimate, but appears to be about 21 mrads/yr. The measured cosmic ray μ-meson flux in the basement of a 5-story London building was 0.63 particles/cm^2/min. Taking counter geometry into account, this leads to an estimated effective dose of 0.84 particles/cm^2/min. The contribution of the electron–photon showers under these conditions is very small, and the estimated total tissue dose due to cosmic radiation is about 12 mrads/yr. These values are lower than figures presently accepted for cosmic-ray dose. (UK)

33225 MUON SOLAR DAILY VARIATION AT A DEPTH OF 60 METRES WATER EQUIVALENT. Peacock, D. S.; Thambyahpillai, T. (Imperial Coll. of Science and Tech., London). Nature (London), 215: 146-7(July 8, 1967).

It is stated that the solar daily variation of underground secondary cosmic-ray intensity has shown remarkable changes in phase and amplitude during the recent solar minimum. Observations at a London Underground Railway Station, with semi-cubic telescopes, indicated that the solar diurnal wave remained virtually constant in amplitude and phase from November 1960 to July 1964. It would appear that such an observation can be reconciled with the corotation model for solar anisotropy if the upper limiting rigidity was about 130 GV and the free space amplitude below this limit was 0.4%. In contradistinction to the 24-hr wave, the semidiurnal wave has shown no statistically significant variability during the period of observation at the underground site. (UK)

33226 COSMIC RADIATION ANISOTROPY AS A SEPARABLE FUNCTION OF TIME AND RADIATION. Ables, J. G.; Barouch, E.; McCracken, K. G. (Southwest Center for Advanced Studies, Dallas). Planet. Space Sci., 15: 547-55(Mar. 1967).

A method for displaying the data from the worldwide net of neutron monitors is described. The cosmic ray anisotropy is depicted on a contour map showing the dependence of cosmic ray flux upon time and direction. The technique permits study of simultaneous changes in the isotropic and anisotropic components of the cosmic radiation even when these components are changing markedly over a time scale of less than one day. Several examples of the application of this technique are presented, and the manner in which the cosmic ray anisotropy varies as a function of time in response to solar-originated disturbances of the interplanetary medium is discussed in particular. (auth) (UK)

33227 THE LATITUDE DISTRIBUTION, INTEGRAL MULTIPLICITIES, AND COUPLING COEFFICIENTS FOR THE NEUTRON, TOTAL IONIZING, AND HARD COMPONENTS OF COSMIC RAYS. Dorman, L. I. (IZMIRAN, Moscow); Kovalenko, V. A.; Milovidova, N. P. Nuovo Cim. (10), 50B: 27-39(July 11, 1967).

The results of the latitude measurements of cosmic-ray intensity at sea level and in the stratosphere in August–October 1965, during the expedition which covered the route from Enisei River via the Arctic Ocean, Volga River, Caucasus, to Middle Asia are presented. The integral multiplicities of generation and the coupling coefficients were found from the obtained intensity dependences

of various components for observations at sea level, at mountain level, and in the stratosphere. The east–west asymmetry of the total ionizing and hard components for zenith angles of 33° and 53° was found and the coupling coefficients for the oblique components were determined. (auth)

33228 THEORY OF RADIO PULSES FROM COSMIC RAY AIR SHOWERS. Lerche, I. (Univ. of Chicago). Nature (London), 215: 268-9(July 15, 1967).

It is stated that the results of Porter et al., (Nature, 214: 1107 (1967)) on detectable polarised radio pulses emitted from extensive air showers cast serious doubt on the validity of the mechanism for coherent emission suggested by Kahn and Lerche (Proc. Roy. Soc. Lond., Ser. A, 289: 206 (1966)). This mechanism concluded that the separation of positive and negative charges by the Earth's magnetic field should produce an observable polarized (E–W) radio signal of some 60,000 flux units/μsec at 45 Mc for a shower containing some 10^6 electrons and positrons. The primary cosmic ray particle energy was taken to be about 5×10^{15} eV. The purpose of the present communication is to indicate several effects which are ignored in this mechanism and which may play a dominant part in modifying both the intensity and polarisation of the coherent signal. These effects are (i) refractive index variations, (ii) Coulomb scattering, and (iii) time variation of the shower front. A more general theory is needed, which should incorporate several model energy and spatial distributions of particles in order to decide how sensitive is the emission of coherent radiation from showers to energy variation among the particles in the shower and, separately, spatial structure of the shower front. The possibility that the coherent space charge emission may dominate is mentioned. (UK)

33229 MECHANISM OF RADIO EMISSION FROM EXTENSIVE AIR SHOWERS. Allan, H. R. (Imperial Coll. of Science and Tech., London); Neat, K. P.; Jones, J. K. Nature (London), 215: 267-8(July 15, 1967).

It is stated that there is as yet no clear picture of how cosmic-ray air showers can generate detectable pulses of electromagnetic radiation at radio frequencies. Theoretical treatments suggest that the principal mechanism should be the motion of charge due to the lateral displacement of shower particle by the Earth's magnetic field. The polarization to be expected from this geomagnetic mechanism is perpendicular both to the shower axis and to the magnetic field lines. Alternative mechanisms, however, can be envisaged. For a shower which is not electrically neutral, but contains an appreciable excess of negative particles, radiation may also occur as a result of the longitudinal motion. This pseudo-Cherenkov radiation would be polarized radially with respect to the shower axis. Other mechanisms which have been suggested are bremsstrahlung from the delta rays associated with the shower tracks, and acceleration of the ionization electrons in the atmospheric electric field. The bremsstrahlung would be unpolarized, while polarization due to the atmospheric electric field would be typically vertical. Experimental evidence on polarization is indirect and conflicting. The present authors report measurements on the amplitude and polarization of the radio pulse from an unusually large shower recorded by the Haverah Park air shower array. The direction of polarization in the horizontal plane was unequivocally determined, and agrees with that expected from geomagnetic deflection, disagreeing with the other mechanisms mentioned. Experimental details are described. A very large pulse of energy $(2 \pm \frac{1}{2}) \times 10^{19}$ eV was observed. The direction of polarization in the horizontal plane was magnetic N–S, to a precision of about 0.1 radian. The shower producing this radio pulse was analysed very precisely. A topic on which useful conclusions could be drawn was the dependence of radio pulse amplitude on total shower energy. This is discussed, and it is concluded that the observations support the theoretical expectation that the pulse amplitude should be proportional to primary energy. (UK)

33230 CALCULATION OF THE μ MESON SPECTRUM EXPECTED IN THE ZENITH DIRECTION AT SEA LEVEL. Aastroem, K. (Kungl. Tekniska Hogskolan, Stockholm). Ark. Fys., 33: 1-24(1967).

The μ-meson energy spectrum in the zenith direction was calculated based on an analysis of the processes in the atmosphere. The purpose of this calculation was to test the possibility of evaluating the atmospheric influence on the primary cosmic-ray intensity, which is needed for an understanding of the optical properties of μ-meson telescopes. Basic assumptions and the method of evaluation is described in detail. The absolute values of the spectrum calculated in this way lie within 10 to 15% of the measured spectra in the interval 0.1 to 1.5 GeV, kinetic energy, when the values of the inelasticity and the effective interaction mean free path were 0.6 and 120 gcm^{-2} respectively. At higher energies the discrepancies are greater, which is, however, of less importance as regards the practical use of μ-meson telescopes, because the total number of high energy mesons is relatively small. (auth) (Sweden)

33231 ENERGY DETERMINATION IN ELECTRON-PHOTON CASCADES FROM THE ANGULAR DISTRIBUTION IN EMULSIONS. Enge, W. (Christian-Albrecht-Univ., Kiel). Z. Phys., 203: 173-91(1967). (In German).

Five electromagnetic cascades of energies 835, 820, 300, 160, and 85 GeV were measured in the emulsions of an emulsion–tungsten–stack. For small angles the integral angular distributions of the electrons are shown to be functions of the product $E_0 \cdot \Theta$ [GeV · rad] where E_0 is the primary energy of the cascade and Θ the angle up to which electrons were regarded. This is analogous to the well known fact that the integral radial distributions depend on $E_0 \cdot R$ [GeV · rl] in the core of the cascade where R is the radius of a circle inside which electrons were added up. (auth)

33232 NUCLEAR CASCADES GENERATED IN LEAD/IRON ABSORBER BY NUCLEAR-ACTIVE PARTICLES OF EAS. Hibner, J. (Inst. for Nuclear Research, Lodz, Poland). Acta Phys. Pol., 31: 993-1000(1967).

The nuclear-active particles of EAS, initiate nuclear cascades in the absorber. The secondary particles of such cascades can hit more than one detector, simulating in this manner a density of the penetrating component that is greater than the actual value. An attempt is made to determine the "nuclear multiplicative effect", i.e. to determine the probability of i detectors registering when a nuclear-active particle of energy above a certain threshold is incident on the absorber. With the assumption of an appropriate energy spectrum of the nuclear-active particles and highly simplified cascade model, the development of a nuclear cascade in a lead/iron absorber was calculated by means of the Monte Carlo method. The distribution was found of the probability p_i that a penetrating particle incident upon the absorber proves to be a nuclear-active particle which, after multiplication in the absorber, hits i(i = 2, 3, 4, . . .) detectors. This distribution is in good accordance with the result obtained from a statistical analysis of experimental data. (auth)

33233 THE EFFECT OF IONIZATION LOSS ON THE ENERGY SPECTRA OF COSMIC RAY NUCLEI UNDERGOING FERMI ACCELERATION. Ramadurai, S. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 65: 219-26(Apr. 1967).

An analytic expression was derived for the energy spectra of the nuclei undergoing acceleration, and used in the study. The spectra have negative slopes which become steeper with increasing charge of the nucleus. In cases where the rate of acceleration is slow, solar modulation effects were superimposed on the above spectra and it is found that the resulting spectral shapes can be fitted with recent satellite measurements for the energy spectra of various groups of cosmic-ray nuclei at low energies. (auth)

33234 THE MODULATION OF GALACTIC COSMIC RAY ELECTRONS, PROTONS, AND ALPHA PARTICLES AT SOLAR MINIMUM. Ramaty, Reuven. Los Angeles, Univ. of California, 1966. 178p.

Thesis.

The modulation of galactic cosmic rays (protons, alpha particles, and electrons) due to the interaction of the cosmic radiation with the electromagnetic fields in the solar system is studied. This modulation is caused by the scattering of the incoming galactic particles by magnetic irregularities carried by the outflowing solar wind. The resulting processes of diffusion, convection and energy loss by deceleration are treated in terms of the relativistic Boltzmann equation. An anisotropic diffusion equation, including energy losses, is derived by expanding the angular part in momentum space of the distribution function in spherical harmonics. The moment equations, which are used to derive the diffusion equation, are obtained by integrations over momentum space angle only. Unlike previous treatments, this approach does not eliminate the energy as an independent variable. The expected effects of diffusion, convection, and energy loss are presented and a simple formalism for the study of the modulation is deduced. By assuming a uniform galactic model for cosmic rays (in which the cosmic rays are produced in the galaxy and are uniformly distributed over the galactic disk and halo), the production and equilibrium spectra of secondary electrons (negatrons and positrons) resulting from cosmic ray interactions in the galaxy are calculated. These electrons arise from from the decay of secondary pions produced by nuclear interactions of cosmic ray protons and alpha particles with the interstellar gas. It is shown that the uncertainty in the galactic proton and alpha particle intensities because of the unknown residual modulation at solar minimum causes a corresponding uncertainty in the calculated intensity of the secondary electrons mainly in the energy region of 20 to 100 MeV. The equilibrium flux of the secondary

electrons is determined by escape from the galaxy and by ionization, inverse Compton and synchroton energy losses. It is found that in order to make the calculated secondary electron equilibrium spectrum, positron–negatron ratio, and nonthermal radio emission consistent with the measurements, an additional primary electron source of about the same magnitude as the secondary one is needed. By comparing the intensity and energy spectrum of the observed electron intensity at earth and the total calculated galactic flux, it is concluded that the residual modulation of electrons at solar minimum cannot be arbitrarily large. The case of no modulation cannot be definitely excluded. However, it is shown that a consistent residual modulation can be found so that the demodulated electron and proton spectra are consistent with each other from the point of view of secondary production and that the demodulated electron spectrum is in agreement with the observed nonthermal radio emission. It is also found that the demodulated proton and alpha spectra exhibit maxima at energies corresponding to a rigidity of about 1 BV and that the additional primary electron spectrum becomes unnecessary at about the same electron energy. These facts may have important implications on the part played by secondarily produced cosmic rays in the low-energy regions. (Disser. Abstr.)

Direct Energy Conversion

Refer also to abstract 33208.

33235 (CEA-R-3158) L'ELECTROHYDRODYNAMIQUE: UN PROCEDE DE CONVERSION DIRECTE D'ENERGIE A HAUTE TENSION. (Electrohydrodynamics: A High-Tension Direct Energy Conversion Process). **Brun, Serge** (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Apr. 1967. 47p. (In French). Dep.

This analysis consists of a theoretical and practical study of a high-tension electrical power generator based on the Van de Graaff generator principle, the main difference being that the charges produced are transported by a gas in motion and not by a belt. The electrical and thermal properties of such a generator are studied, as well as the production of the ionised particles used in the conversion. Some results already published on this process for converting kinetic energy into electrical energy are given, as well as some possible applications in the field of space technology. (auth)

33236 THERMOELECTRON EMISSION FROM HAFNIUM AND ZIRCONIUM CARBIDES. **Gorbatyi, N. A.; L'vov, G. V.; Perederii, V. A.; Reshetnikova, L. V., Fekhretdinov, F. A.** (Tashkent State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1942-9(Dec. 1966). (In Russian).

Thermoelectron emission from HfC and ZrC, the work functions, Richardson constants, and current densities were recalculated for those materials under rigorously controlled conditions. The HfC samples contained 94% metal, 5.3% bound C, and 0.40% free C, and their lattice constant was 4.632 KX. The CrC samples contained 88.95% metal, 10.05% bound C, and 0.40% free C, and their lattice constant was 4.679 KX. The Richardson method was used for the measurements of the basic characteristics, and the thermoelectron constant was assumed to be 120.4 amp $\cdot$ cm^{-2} $\cdot$ deg^{-2}. In half of the samples the carbides were deposited directly on tantalum substrates, and in the other half on tantalum coated with $MoSi_2$. The work function of HfC on tantalum was found to be 3.0 eV, its Richardson constant 0.3 amp $\cdot$ cm^{-2} $\cdot$ deg^{-2}, current density at 1920K was 17.6 and at 2140K 137 mA $\cdot$ cm^{-1}, and its effective work function 3.75 eV. The corresponding values for HfC on $MoSi_2$ were 3.0 eV, 1.8 amp $\cdot$ cm^{-2} $\cdot$ deg^{-2}, 91 and 790 mA $\cdot$ cm^{-1}, and 3.75 eV. The work function of ZrC on tantalum was 2.7 eV, the Richardson constant 0.15 amp $\cdot$ cm^{-2} $\cdot$ deg^{-2}, current density at 1920K was 46 and at 2140K 306 mA $\cdot$ cm^{-1}, and the effective work function 3.85 eV. The corresponding values for ZrC on $MoSi_2$ were 3.0 eV, 0.7 amp $\cdot$ cm^{-2} $\cdot$ deg^{-2}, 36 and 286 mA $\cdot$ cm^{-1} and 3.87 eV. (ATD)

33237 ELECTRON FLOW IN LOW-DENSITY ARGON GAS INCLUDING SPACE CHARGE AND ELASTIC COLLISIONS. **Goldstein, Charles M.** (Lewis Research Center, Cleveland). J. Appl. Phys., 38: 2977-84(June 1967).

The characteristics of one-dimensional electron diode with low-pressure argon scattering gas are analyzed by a Monte Carlo method. Experimentally determined differential elastic scattering cross sections, extrapolated to zero energy, are employed. Current–voltage characteristics are compared with those obtained from a hard-sphere collision model. Negative resistance is found for low emission current densities and low pressure as a result of the Ramsauer cross section. The randomization of energy between velocity components is found to be quite large for accelerating potentials and pressure-electrode separation values as low as ½ torr cm. The energy dependence of total cross section has a more pronounced effect on the current–voltage curves than nonisotropic scattering. (auth)

33238 LARGE-CAPACITY MHD GENERATORS USING FUEL-COMBUSTION PRODUCTS. **Shakhtarin, V. N.; Boltukhova, S. N.** pp 215-25 of Teoriya, Raschet i Issledovaniya Vysokoispol'zovannykh Elektricheskikh Mashin. Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Fundamental design calculations for a 1000-Mw MHD generator are presented: channel shape and length, magnetic-system data, generator weight, and size. A set of equations describing the flow of ideal gas in a variable cross section channel is used to deduce formulas for generator operating parameters. Distribution of temperature, pressuure, cross section, and load parameter (electrical efficiency) along the channel is estimated for two versions: (1) constant gas conductivity, 30 mhos/m and (2) gas conductivity $\sigma = c\ (T^{\frac{1}{2}}/p^{\frac{1}{4}})$. Magnetic systems are calculated in two versions: (1) steel-core system with a total steel-copper weight of 7.73 to 9.39 kg/kw and (2) ironless coil system with deep cooling. (JPRS)

33239 THERMOMAGNETIC DEVICES. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,076,036. July 19, 1967. Priority date Nov. 8, 1963, Germany.

A thermomagnetic device is described, comprising a thermomagnetically active solid body having a first pair of opposite faces spaced one from the other in a first direction and adapted to form relatively warm and cold sides respectively of the body when the device is in use. The device has also a second pair of opposite faces spaced one from the other in a second direction which is substantially perpendicular to the first direction. Two electrical contacts are mounted respectively on the second pair of opposite faces for connecting an external circuit to the body. Between the second pair of opposite faces the body has a multiplicity of elongate or laminate regions of relatively high electric conductivity alternating with material having relatively low electric conductivity and finite Hall mobility. The said regions are oriented substantially parallel with one another and the said first direction. Magnet means is included for providing a magnetic field in which the solid body is mounted so that the said first and second directions are substantially perpendicular to the magnetic field direction at the body. In one embodiment the said material is a bismuth–antimony alloy. (M.H.R.)

Fluid Physics

Refer also to abstracts 33235 and 33238.

33240 (SSD-TR-67-74) AN ELECTRODE FEED SYSTEM FOR A SEGMENTED ELECTRODE MHD ACCELERATOR. **Durran, D. A.; Grabowsky, W. R.** (Aerospace Corp., El Segundo, Calif. Aerodynamics and Propulsion Research Lab.). May 5, 1967. 17p. (TR-1001(2240-10)-9).

The distribution of power to a large number of electrodes in a segmented electrode, cross-field accelerator requires a very complex feed system if each electrode pair is to be electrically isolated from all others to prevent the undesirable flow of current in the axial direction. An arrangement for interconnecting groups of electrodes on a single feed system (and power supply) that also supplies the requirements for zero axial current flow has been developed for the Aerospace MHD wind tunnel. The characteristics of this electrode feed system and its advantages, at least for a pulse-type facility, are described. (auth)

33241 FLOW INDUCED IN A CYLINDRICAL COLUMN BY A UNIFORMLY ROTATING MAGNETIC FIELD. **Devanathan, C.; Bhatnagar, P. L.** (Indian Inst. of Science, Bangalore). Proc. Roy. Soc. (London), Ser. A, 297: 558-63(Mar. 21, 1967).

Under laboratory conditions the magnetic Reynolds number is quite small in a conductor, but can be made appreciable if a high-frequency rotating field is applied. Moffatt investigated this problem for high magnetic Reynolds numbers and concluded that there existed a magnetic boundary layer due to spiralling of field lines. Applying Fourier transforms and solving the corrected equations, it is found that at low magnetic Reynolds numbers the field lines uniformly penetrate the cylindrical column and do not exhibit any appreciable spiralling. The rotation opposes the drift due to conductivity which is evened out in proceeding from the center to the surface. This uniform behavior persists for small magnetic Reynolds number inside and outside. When the magnetic Reynolds number becomes large, of the order of 100, the field lines passing through the axis of the cylinder exhibit spiralling as suggested by Moffatt since the diffusion is unable to counterbalance the rotational effects. (auth) (UK)

33242 CROSSED-BEAM CORRELATION TECHNIQUE. **Fisher, M. J.** (IIT Research Inst., Chicago); **Krause, F. R.** J. Fluid Mech., 28: 705-17(1967).

An experimental technique is described which allows estimates of local turbulent properties of a shear layer to be obtained without the necessity of inserting a probe into the flow field. Two beams of radiation, which pass through the entire flow field in two mutually perpendicular directions, are employed. It is shown that, although each beam independently reflects only an integral of the flow properties along the entire path between the source and detector, the covariance between the two detected signals yields local turbulent information. Experimental results are presented for the shear layer of a subsonic jet and are shown to be in good agreement with published hot-wire data. (auth) (UK)

33243 MEASUREMENT OF THE GROWTH OF A TURBULENT MERCURY JET IN A COAXIAL MAGNETIC FIELD. Sajben, Miklos; Fay, James A. (Massachusetts Inst. of Tech., Cambridge). J. Fluid Mech., 27: 81-96(Jan. 11, 1967).

Using a hot-wire system developed for this purpose, measurements of the velocity were made in a circular liquid-mercury jet issuing into a low-speed secondary flow and subject to a uniform axial magnetic field. The Reynolds number of the jet was about 10,000 while the magnetic interaction parameter varied from zero to slightly over one. The jet was strongly turbulent under all conditions investigated. The radial distribution of the mean and fluctuating component of the meridional velocity was measured at four axial stations located between 2 and 34 diameters from the nozzle exit. The results indicate that the rate of spreading of the jet is decreased, that the shape of the velocity profile changes and that the turbulent intensity decreases with increasing magnetic-field strength. The high-frequency components of the fluctuations in the second flow seem to be damped more strongly than fluctuations at low frequencies, while the reverse is observed within the core of the jet. (auth)

33244 CRITICAL LAYER FOR INTERNAL GRAVITY WAVES IN A SHEAR FLOW. Booker, John R. (Inst. of Geophysics and Planetary Physics, La Jolla, Calif.); Bretherton, Francis P. J. Fluid Mech., 27: 513-39(Feb. 24, 1967).

Internal gravity waves of small amplitude propagate in a Boussinesq inviscid, adiabatic liquid in which the mean horizontal velocity U(z) depends on height z only. If the Richardson number R is everywhere larger than $\frac{1}{4}$, the waves are attenuated by a factor $\exp\{-2\pi(R-\frac{1}{4})^{\frac{1}{2}}\}$ as they pass through a critical level at which U is equal to the horizontal phase speed, and momentum is transferred to the mean flow there. This effect is considered in relation to lee waves in the airflow over a mountain, and in relation to transient localized disturbances. It is significant in considering the propagation of gravity waves from the troposphere to the ionosphere, and possibly in transferring horizontal momentum into the deep ocean without substantial mixing. (auth)

33245 DUAL SOLUTIONS OF THE MAGNETOGASDYNAMIC BOUNDARY-LAYER EQUATIONS. Ingham, D. B. (Univ. of Leeds, Eng.). J. Fluid Mech., 27: 145-54(Jan. 11, 1967).

The work of Wilson (1964) is extended to include the effect of compressibility in the recurrence of dual solutions in the flow in the boundary layer on a semi-infinite, thermally insulated, flat plate placed at zero incidence to a uniform stream of electrically conducting gas with an aligned magnetic field at large distances from the plate. Numerical integration of the boundary-layer equations has been performed for several values of the ratio, β, of the square of the Alfvén speed to the fluid speed in the undisturbed fluid, the conductivity parameter $\epsilon = 0.1$ and ∞ and the square of the Mach number $M^2 = 0, \frac{1}{2}, 1, 2, 2.5, 4$ and 5. The effect of compressibility is to increase the value of β for which a solution can exist such that the skin friction at the plate is greater than zero. Dual solutions are seen to occur for non-zero Mach number and all values of ϵ but no attempt here has been made to explain this phenomenon. An analytic argument indicates that no solutions of the equations exist if the skin friction at the plate is greater than zero and if the vorticity and current decay exponentially, the condition for which is $M^2 < 1$, $\beta > 1/(1-M^2)$. Nothing specific has been proved if this condition is not satisfied. (auth)

33246 HYDROMAGNETIC STABILITY OF DISSIPATIVE FLOW BETWEEN ROTATING PERMEABLE CYLINDERS. PART 1. STATIONARY CRITICAL MODES. Chang, Tien Sun; Sartory, Walter K. (Oak Ridge National Lab., Tenn.). J. Fluid Mech., 27: 65-79(Jan. 11, 1967). (ORNL-P-1610).

The theory of stability of the flow of a viscous, electrically conducting fluid between rotating cylinders in the presence of an axial magnetic field is extended to the case where the cylinders are permeable and the primary flow includes a radial component. Numerical results pertaining to the stationary axially symmetric modes are presented, and the asymptotic stability behavior for large values of the radial Reynolds number is derived. (auth)

33247 STABILITY OF NONISOTHERMAL PLASMA FLOW IN A PLANE MHD CHANNEL. Sanochkin, Yu. V. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 3-7(Jan.-Feb. 1967). (In Russian).

Although previous studies on stability in laminar flow through a transverse magnetic field assumed that transfer coefficients were independent of such conditions as temperature, calculations reveal that temperature distribution does have a great effect on flow dynamics when subsonic velocity is relatively low in an incompressible medium. Flow rates in a plane MHD channel (termed nonisothermal) have proved to be seriously distorted under certain circumstances. In this study hydrodynamic stability of plasma flow through transverse electric and magnetic fields in a plane channel lined with dielectric walls is examined. The equations derived for disturbed stability cover all instability mechanisms, but their solution is difficult. A formula is given for determining the original stationary state, based on the axis of flow, of the external magnetic field and the constant electric field, while relating the transfer to temperature. Another series of formulas is developed to linearize minor stability distortions, based on the rate of disturbed flow, magnetic field, temperature, electric and thermal conductivity, and stream viscosity. Instability due to excess heating and to vortical speed gradients is analyzed in relation to oblique magnetic lines, by referring to formulas cited from a number of previous works. (ATD)

33248 TWO-DIMENSIONAL FLOWS AT FINITE REYNOLDS NUMBERS. Eliseev, B. V.; Lobanov, A. D. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 14-20(Jan.-Feb. 1967). (In Russian).

In analyzing the strong influence of an induced magnetic field on a gas stream at finite Reynolds numbers, the flow dispersion is ascertained and the effect is assessed of perpendicular Lorentz force components in a two-dimensional channel with electrodes. The effect is also analyzed of speed non-uniformity along a flow of incompressible fluid when the Reynolds numbers are fairly large. A system of equations is given to define the magnetic field in relation to its axes, channel dimensions, and distance between electrodes. These are solved by applying a Fredholm integral equation and successive approximations. Multi-dimensional flow in a narrow channel is briefly discussed, and uni-dimensional flow rates in a broad channel are analyzed, with the aid of formulas derived for effects of fluctuating flow rates and fluctuating field potentials. Propagation of two-dimensional velocity fluctuations along a stream in a broad channel is analyzed, and formulas are given for motion continuity, fluctuation coefficients, magnetic field diffusion and potential, and flow disturbance forces, all of which are governed by channel dimensions and magnetic conditions along the channel walls. (ATD)

33249 REDUCTION OF VISCOUS FLOWS HAVING ORTHOGONAL MAGNETIC AND VELOCITY FIELD DISTRIBUTIONS. Power, G. (Nottingham Univ., Eng.); Walker, D. Appl. Sci. Res., 17: 223-32(1967).

Certain steady magnetohydrodynamic flows of a viscous incompressible fluid, in which the magnetic field is everywhere orthogonal to the velocity field, are related to viscous compressible flows having zero magnetic field. Examples are given to illustrate this relationship. Other linked magnetic and nonmagnetic flows can be found using similar processes. (auth)

33250 MAGNETOHYDRODYNAMICAL FLOW IN A CHANNEL IN THE CASE OF THE NON-HOMOGENEOUS ELECTRICAL BEHAVIOR OF ITS WALLS. Wolfersdorf, L. V. Stud. Cercet. Mec. Apl., 18: 285-98(1965). (In Romanian).

The stationary flow of a viscous electrically conductive incompressible medium between two parallel walls is considered for the case of a perpendicular outer magnetic field. The walls are made up of two halves of different conductivity. Wiener–Hopf's technique is resorted to in solving the problem. The simplest case of the problem considers half-conductive and half-isolated walls. In this case, the nondimensional mass flow and the ratio of the Lorentz force to the pressure gradient in the separating surface of the two channel halves are calculated for small Hartmann numbers. (Romanian Sci. Abstr.)

33251 EXPERIMENTAL AND THEORETICAL ANALYSIS OF MAGNETOFLUIDMECHANIC CHANNEL FLOW. Brouillette, Eugene Clyde. Lafayette, Ind., Purdue Univ., 1966. 142p. Thesis.

The magnetofluidmechanic turbulent channel flow was investigated experimentally and theoretically. The experiments covered a range of Reynolds number, $58{,}000 \leq Re \leq 180{,}000$, and Hartmann number, M, up to 750, the corresponding transverse magnetic field being sufficient to bring about the "transition" from turbulent to laminar flow at the maximum Reynolds number attained. Skin friction and mean velocity measurements were made in a rectangular cross section (1.4 in. × 7 in.), insulated wall channel the terminal 50 in. of which were between the pole tips of a large electromagnet. Most of the balance of the 114-in. total length was utilized in the upstream hydraulic entrance length of 60 in. The channel section formed part of a continuous flow loop in which mercury was circulated by a centrifugal pump. (TSS) (Disser. Abstr.)

33252 COUETTE FLOW OF A PARTIALLY IONIZED SYMMETRIC DIATOMIC GAS. Matar, Said El-Sayed Mohamed. Evanston, Ill., Northwestern Univ., 1966. 178p.

Thesis.

The Couette flow of a partially ionized symmetric diatomic gas with and without an applied magnetic field is analyzed for both chemical equilibrium and frozen flow. The gas mixture is considered to consist of molecules, atoms and ion–electron particles diffusing together as one particle. This ternary model of diffusion limits the treatment to types of flow where self-generated and imposed electric fields are absent. The number of ion and electron particles in the mixture is considered to be a small, but significant, percentage of the neutral particles and the analysis is carried out in a linearized fashion. In evaluating the specific heat, enthalpy and pressure the four components are considered. The multicomponent diffusion coefficients are obtained in terms of the atom–molecule binary diffusion coefficients and the mass fractions of atoms and ion–electron particles. Analytical solutions of the atomic and ion–electron diffusive mass fluxes are obtained. For the flow case where there is no magnetic field, analytical closed form solutions for particle concentrations, in the flow layer as well as at the boundaries, are obtained by using series expansion techniques in both cases of chemical equilibrium and frozen flow. The heat transfer rate (expressed through the Nusselt number), the skin friction, and the enthalpy recovery factor are obtained in integral form and are solved numerically for nitrogen. All solutions obtained for the ionized gas flow are compared with the Couette flow of a dissociated diatomic gas (ionization suppressed). Ionization is found to split the atom mass flux, when the gas is in chemical equilibrium, into two streams: one is towards the lower wall and the other is towards the upper wall. The ion–electron mass flux, however, is towards the lower wall. When the flow is frozen, both atomic and ionized particles mass fluxes are diffusing towards the lower wall. Ionization is found to have a marked effect on temperature distribution and the recovery enthalpy factor, but a negligible effect on the skin friction. The heat transfer rate increases with the degree of ionization. The solutions for the diffusive mass fluxes, the particles concentrations and approximate formula for dissociation and ionization equilibrium constants, are used to calculate the "equilibrium" thermal conductivity. The results show better agreement with the experimental measurements than previous theories dealing with ionized diatomic gases. When a magnetic field is applied to the flow, the functional form of the transport coefficients are assumed not to be altered and solutions are presented in integral form. Numerical calculations carried out for nitrogen show that the magnetic field decreases the heat transfer rate and the skin friction, but increases the total drag. The magnetic field effects on the frozen flow are larger than its effects on the chemical equilibrium flow. (Disser. Abstr.)

33253 MAGNETOHYDRODYNAMIC FLOW THROUGH CURVED AND STRAIGHT PIPES. Sahai, Vireshwar. Blacksburg, Va., Virginia Polytechnic Inst., 1966. 85p.

Thesis.

The effect of a magnetic field on the steady flow of conducting fluids in curved and straight pipes is investigated. Governing equations for such a flow, good for pipes of arbitrary cross sections, are derived. These equations are made somewhat simpler by making the assumption that the cross-sectional dimensions are small compared to the radius of curvature of the pipe. They are then linearized by expanding the velocity and magnetic field components in an asymptotic series involving the powers of the Dean's number. This results in a series of linear equations which must be solved successively. (TSS) (Disser. Abstr.)

33254 INTRODUCTION TO MAGNETOHYDRODYNAMICS. Roberts, P. H. London, Longmans, 1967. 264p. 60s.

The subject is discussed under the following main headings: the equations of magnetohydrodynamics; electromagnetic induction, homogeneous dynamos; hydromagnetic equilibria and force-free fields; Alfvén waves; boundary layers; hydromagnetics of the laboratory; and hydromagnetic stability. (UK)

33255 DEVICE FOR ACCELERATING THE FLOW OF A LIQUID. Lang, Hermann; Radebold, Reinhart; Westphal, Walter. British Patent 1,075,303. July 12, 1967. Priority date Aug. 17, 1963, Germany.

A device for accelerating the flow of a liquid is described. This device is characterized in that part of the liquid is vaporized directly or indirectly by heat produced in a nuclear reactor, while the remaining part of the liquid is utilized for the condensation of the vaporized liquid. As a result of this arrangement, a satisfactory condensation of the vaporized working medium at a high energy level can be obtained. This device is to be used for providing the liquid working medium for an MHD converter. (M.H.R.)

Geophysics

Refer also to abstract 32430.

33256 (AD-632264) LATITUDINAL AND DIURNAL VARIATIONS OF THE IONOSPHERIC ELECTRON CONTENT NEAR THE AURORAL ZONE IN WATER. Liszka, Ludwik (Kungliga Vetenskapsakademien, Kiruna (Sweden). Geofysiska Observatoriet). Dec. 7, 1965. Contract AF61(052)-678. 12p. (AFCRL-66-223). CFSTI.

The analysis of three month's observations of Faraday rotation on S-66 transmissions made at Kiruna Geophysical Observatory (67.8 degrees N, 20.3 degres E) is presented. The ionospheric electron content along the subionospheric path of the satellite was computed for almost 400 transits. Also effective slab thicknesses were calculated using critical frequency values from 6 Scandinavian stations, covering an interval of 10 degrees of latitude. Latitudinal and diurnal variations of the ionospheric electron content and the effective thickness were studied. The most striking feature of the latitudinal variation of the total electron content was a distinct minimum at the southern boundary of the auroral zone during winter nighttime. This minimum coincides with the "trough" observed by topside sounding satellites. (auth) (TAB)

33257 (AD-632565) PROPAGATION OF Pc1 MICROPULSATIONS IN AN IONOSPHERIC DUCT. Manchester, R. N. (Newcastle Univ. (Australia). Dept. of Physics). Feb. 1966. Contract Nonr(G)-00027-65. 48p. CFSTI.

The propagation mechanism of Pc 1 micropulsations from their relatively high generation latitude to middle and low latitudes is considered. The study is confined to the type of micropulsations commonly known as pearls or hm emissions. It is shown that propagation probably takes place in a duct centred on the F region of the ionosphere. The diurnal variations of the duct properties are calculated, using typical profiles for the ionospheric parameters at the time of sunspot minimum. It is shown that the duct has a low-frequency cutoff at about 0.5 cps, implying that the lack of low-frequency events at middle latitudes may be largely a propagation effect. Duct attenuation is very small during the night hours when the majority of Pc 1 events are observed at middle latitudes, but is very large during the day. The calculated average horizontal component of the phase velocity for propagation in the duct is of the same order as that given in initial reports of experimental observations. (auth)

33258 (AD-634953) IONOSPHERIC RESEARCH USING SATELLITES. Annual Report No. 2, January 1, 1965–February 28, 1966. Anastassiadis, Michael (National Observatory, Athens (Greece). Ionospheric Inst.). Contract AF61(052)-754. 28p. (AFCRL-66-388). CFSTI.

The Ionospheric Institute recorded a large number of transmissions from active satellites S-66 and BE-C on 40 Mc, following a common program established by Joint Satellite Study Group. Some results on large-scale irregularities are discussed and a new method to calculate the ionospheric horizontal gradient in electron content is presented. (TAB)

33259 (N-67-15900) CISLUNAR ELECTRON CONTENT AS DETERMINED BY RADAR GROUP DELAY MEASUREMENTS. Howard, H. T. (Stanford Univ., Calif. Radioscience Lab.). Nov. 1966. 27p. (NASA-CR-81279; SEL-66-113; SR-17). CFSTI.

The 25- and 50-MHz radars were modified to improve power output and time resolution and, through the months of July and August, 1965, were used to determine cislunar electron content during 55 lunar meridian transits. Ionospheric electron contents, determined by the Faraday rotation on 136-MHz signals from Syncom III, were combined with calculated protonospheric values and subtracted from each radar determination of total content. The results reinforce the earlier conclusion that there are two distinct regions beyond the plasmasphere. In the general direction of the sun where most of the radar path is beyond the shock wave boundary, the average electron number density is very low: 11 ± 30 cm^{-3}. Within the solar wind wake of the earth, in the quadrant opposite the sun, the columnar content from approximately 4 R_E to the moon is $4.9 \pm 1.2 \times 10^{16}$ electrons m^{-2}. If this content were spread evenly along the path, it would imply a number density of 120 ± 30 cm^{3}. The wake density and possibly its shape appear to change on a day-to-day basis. (auth) (STAR)

33260 TWILIGHT Ca^+ EMISSION FROM METEOR TRAILS UP TO 280 km. Broadfoot, A. L. (Kitt Peak National Observatory, Tucson, Ariz.). Planet. Space Sci., 15: 503-14(Mar. 1967).

New observations of Ca^+ emission in the twilight spectrum are reported and resonance scattering of sunlight is confirmed. Ca^+ emission has been detected through the altitude range from 100 to 280 km. The observations are well correlated with the increase in meteor activity during the spring and summer months, and are ex-

plained as resonance scattered emission from Ca^+ ions deposited in the field of view by the arrival of meteorite material. Order of magnitude calculations are made using the theory which was developed to describe the evaporation of meteorites in the 100-km region. This theory does not explain the Ca^+ observations. Diffusion of the Ca^+ ions would be slow enough to sustain a cloud of ions in the field of view of the instrument throughout the twilight observing period. (auth) (UK)

33261 OBSERVATION OF THE AIRGLOW H_α EMISSION. Armstrong, E. B. (CSIRO, Camden, Australia). Planet. Space Sci., 15: 407-25(Mar. 1967).

An attempt was made during 1965 to observe the diurnal and seasonal variations of the H_α emission from the geocorona with a very simple photometer. Because of its simplicity the instrument was susceptible to disturbing radiations; the effects upon it of light from sources other than the geocoronal hydrogen are discussed in some detail. The observational results, which were very dependent upon the geometry of the Earth's shadow, are believed to be a good indication of the variation of the H_α emission. The buildup of hydrogen content during the night was demonstrated and is discussed, the time at which it reached its maximum diurnal value being inferred to be soon after midnight. It is suggested that the distribution with altitude of the hydrogen in the thermosphere and exosphere changes markedly towards dawn, the gas rising to great heights due to an increasing exosphere base temperature before base dawn. No strong evidence for a concentration of hydrogen towards the plane of the ecliptic was seen, neither was there any convincing indication of a Brandt geocoma. The absolute intensity of the H_α emission was inferred from observations of the Orion nebula and was found to be several times greater than would be expected from the reported intensity of the solar L_β line. (auth) (UK)

33262 GEOMAGNETIC CAVITY AND THE VAN ALLEN RADIATION BELTS. II. Rajappa, N. (National Aeronautical Lab., Bangalore, India); Venkatarangan, P.; Viswanathan, K. S. Planet. Space Sci., 15: 495-502(Mar. 1967).

Using the spherical harmonic expansion given by Mead [J. Geophys. Res., 69: 1181(1964)] for the magnetic field created by the currents on the surface of the geomagnetic cavity, the nature of the trapping regions has been discussed. It is shown that to a first order of approximation in the expansion coefficients the allowed regions are still determined by a cubic equation. Numerical determinations were made for the structure of the allowed regions for particles of different energies both on the sunlit side as well as the dark side of the Earth. (auth) (UK)

33263 GEOMAGNETIC PULSATIONS ASSOCIATED WITH SUDDEN COMMENCEMENTS AND SUDDEN IMPULSES. Saito, Takao; Matsushita, S. (National Center for Atmospheric Research, Boulder, Colo.). Planet. Space Sci., 15: 573-87(Mar. 1967).

Damped-type geomagnetic pulsations associated with both storm sudden commencements (ssc's) and sudden impulses (si's) are studied for 388 events which occurred during the past 7 years from 1956 through 1962. Since the pulsations associated with ssc's and with si's usually showed very similar behavior, they are combined together under a notation, psc. These psc's are classified into four groups according to period ranges in a similar way as pc's: psc 1, 0.2 to 5 sec; psc 2.3, 5 to 30 sec; psc 4, 30 to 150 sec; psc 5, 150 to 600 sec. Predominant psc's in middle and low latitudes, subauroral region, and auroral zone are psc 2.3, psc 4, and psc 5, respectively. Morphological behavior of psc's, such as daily variations of their amplitudes and periods, and patterns in their dynamic spectra, show a remarkable similarity to those of corresponding period-range pc's. However, the psc's show an interesting dependence on the range and duration of accompanying ssc's. A brief discussion in given on these characteristics of psc's. (auth) (UK)

33264 THE SPATIAL VARIATION OF AURORAL LUMINOSITY. I. THE BEHAVIOR OF SYNTHETIC MODEL AURORAS. Romick, G. J.; Belon, A. E. (Univ. of Alaska, College). Planet. Space Sci., 15: 475-93(Mar. 1967).

The determination of the spatial distribution of auroral luminosity using two-station triangulation techniques requires a knowledge of the geometrical effects of perspective and path length on the observations. In order to evaluate these effects model synthetic aurora with known vertical and horizontal luminosity profiles were constructed mathematically and were programmed into a high speed electronic computer. The appearance (intensity vs zenith angle) of these model auroras positioned at various latitudes from each of the observing stations was then calculated. The analysis of this computed data has led to the formulation of a procedure for the determination of the spatial distribution of the volume emission rate of various auroral emissions within isolated discrete auroral forms. In addition, the analysis provides information pertinent to the interpretation of auroral observations obtained through commonly used optical techniques. It is shown that the observed intensity and appearance of an aurora as a function of zenith angle are highly dependent on the luminosity distribution within the auroral form and the distance to the aurora. The accuracy of the height and latitude of auroral forms determined by triangulation techniques depends on the position of the aurora with respect to the stations. The highest accuracy in location is obtained for auroras between stations, but this is where the lowest accuracy in height occurs. Conversion of intensity vs zenith angle observations into an intensity vs height profile is a satisfactory first order approximation to the actual vertical volume emission rate profile if the height or location of the aurora is known. The most accurate profiles are determined for auroras positioned over the most poleward station when viewed by an equatorward station at least 200 km away. Observations of auroral intensities in a fixed direction are most easily interpreted when directed towards the magnetic zenith. In that direction path length effects are height dependent only. Therefore the intensities measured can be directly related to the energy deposit of the incident particles and the fraction of the energy distributed among the various excited auroral emissions can be determined. (auth) (UK)

33265 ATOMIC NITROGEN IONS IN THE UPPER ATMOSPHERE. McElroy, Michael B. (Kitt Peak National Observatory, Tucson, Ariz.). Planet. Space Sci., 15: 457-62(Mar. 1967).

Possible mechanisms for production of N^+ are discussed and it is argued that dissociative photoionization of N_2 dominates below 380 km. Photoionization of N is shown to be a minor source of atmospheric N^+. The results are compared and agree satisfactorily with mass-spectrometric measurements. It is pointed out that N^+ is produced with kinetic energy, and some possible consequences for laboratory measurements and for the topside ionosphere are briefly discussed. (auth) (UK)

33266 RESONANT INTERACTIONS BETWEEN ENERGETIC TRAPPED PARTICLES AND A TRANSVERSE ELECTROMAGNETIC WAVE. Willis, D. M. (Radio and Space Research Station, Ditton Park, Eng.). Planet. Space Sci., 15: 557-71(Mar. 1967).

The resonant interactions between energetic trapped particles of either sign and a weak, transverse (in the sense of propagation), electromagnetic wave in the extraordinary mode are considered in detail. Resonant interactions arise when the wave frequency is an integral multiple of the particle gyrofrequency, as is to be anticipated on physical grounds. At the resonant frequencies particles may be either accelerated or decelerated in a direction perpendicular to the magnetic field, depending on the parameters of the problem. Therefore the resonant interactions produce a continuous increase or decrease, respectively, in particle pitch angles. Conditions under which the various resonances may be suppressed are examined and some tentative geophysical applications of the theory are discussed briefly. In particular, it is suggested that protons in the outer radiation belt may be either energized or precipitated by this resonant interaction process. It is speculated further that the present mechanism could contribute to changes in the quiet-time ring current and the precipitation of protons at conjugate points. (auth) (UK)

33267 HYPERSONIC ANALOGUE AS APPLIED TO PLANETARY INTERACTION WITH THE SOLAR PLASMA. Dryer, Murray; Heckman, Gary R. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Planet. Space Sci., 15: 515-46 (Mar. 1967).

The classically reducible problem in magnetogasdynamic steady inviscid flow as first noted by Kogan [Prikl. Mat. Mech., 23: 70 (1959)] is applied (to first order) to the interaction of the solar plasma with planetary magnetic fields. Earlier studies of this analogue are extended (on the basis of experimental data) by adopting a more realistic magnetospheric boundary and more appropriate values for the ratio of specific heats, γ, and magnetoacoustic Mach number, M_{ms}*. Data from the Mariner 4 encounter with Mars, as well as Imp-1, Imp-2, Pioneer 6, and Ogo-1 experience in the vicinity of Earth, indicate that γ can be as low as 1.2 (rather than the values of 2 and 5/3 used heretofore). Complete details of the flow field parameters, including the magnetic field for the reducible case of an interplanetary aligned magnetic field, are given in a form which is convenient for comparison with experimental data and for scaling purposes for Venus, Mars, and other planetary bodies. This application is referred to as the "hypersonic analogue" which, in its broadest sense, is also used for arbitrary magnetic field orientation with respect to the velocity vector. Comparison with satellite data is made in applicable cases such as mass flux intensities and magnetic field magnitudes. The tail is assumed too close at 1000 Earth radii, as suggested by Dungey.

The primary purpose is to describe the analogue as a useful theoretical vehicle which can be used to contribute to analysis of the overall energy balance between the incident solar wind and the planetary environs. The pressure distribution, due to both thermal and magnetic effects on the boundary, produces a drag on the magnetosphere. This drag, due to the Earth's relative motion through the solar plasma, appears as energy dissipation in the shock wave. Once the plasma parameters are known everywhere along the magnetopause, a straightforward estimate of energy transfer into the magnetosphere via viscosity is made in the form suggested by Axford [Planet. Space Sci., 12: 45(1964)]. The results are consistent with Axford's order of magnitude calculation. It is suggested, however, that a monotonically increasing boundary layer growth (which begins at the subsolar point) also requires a monotonically increasing electric potential across the magnetosphere rather than a constant value. It is shown that the boundary layer can be as thick as 1.6 Earth radii on the night side. (auth) (UK)

33268 DISTURBANCE OF A RAREFIED PLASMA BY A SUPERSONIC BODY ON THE BASIS OF THE POISSON–VLASOV EQUATIONS. II. FORMAL METHOD. Taylor, J. C. (London Univ. United Kingdom Atomic Energy Authority, Culham, Eng.). Planet. Space Sci., 15: 463-74(Mar. 1967).

A boundary value problem for the electrical potential and the ion distribution function controlled by the Poisson–Vlasov equations has been solved in two ways, one of which is discussed. The problem arises in studying the disturbance of a rarefied plasma by a supersonic body, for example a satellite traversing the ionosphere. The two methods are iterative in nature and have the same zero-order solutions. The solution to first order is presented by what is called the Formal Method. The other method, called Heuristic, has been discussed previously. The results show surprisingly close agreements between two approaches which are mathematically so different. Although little can be said at this stage about the accuracy of the results, their mutual corroboration is reassuring. Recent Russian work (Al'pert, Gurevich and Pitaevskii, 1963, 1965; Maslennikov and Sigov, 1965) based again on a different mode of calculation also seems to support the results presented. (auth) (UK)

33269 REACTION OF ATOMIC OXYGEN IONS WITH VIBRATIONALLY EXCITED NITROGEN MOLECULES. Schmeltekopf, A. L.; Fehsenfeld, F. C.; Gilman, G. I.; Ferguson, E. E. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Planet. Space Sci., 15: 401-6(Mar. 1967).

Laboratory experiments show that the ion–atom interchange reaction $O^+ + N_2(T_v) \rightarrow NO^+ + N$ has an increased rate constant when the N_2 is vibrationally excited. For a Boltzmann distribution of N_2 vibrational states such that $T_v = 4000°K$, the rate constant is increased by a factor of about twenty over the rate constant for ground vibrational state N_2. This has important implications for electron loss rates in the ionosphere. The vibrational effect can account for previous laboratory measurements which yielded larger rate constants than were measured in the authors' laboratory. (auth) (UK)

33270 DYNAMIC EFFECTS ON ATOMIC AND MOLECULAR OXYGEN DENSITY DISTRIBUTIONS IN THE UPPER ATMOSPHERE: A NUMERICAL SOLUTION TO EQUATIONS OF MOTION AND CONTINUITY. Shimazaki, Tatsuo (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Atmos. Terrest. Phys., 29: 723-47(June 1967).

Equations of motion and continuity for atomic and molecular oxygen density in regions between 70 and 170 km are solved numerically as a time-dependent problem. An implicit numerical method is useful to solve the system of equations. The results indicate that atmospheric diffusion and mixing play an important role in determining the [O] and [O_2] distributions. These distributions finally approach a steady state in which the dissociation term is balanced with the transport term due to molecular diffusion in higher regions, while the recombination term is balanced with the transport term due to eddy mixing in lower regions. Comparison of height variations in [O]/[O_2] and the mean molecular weight in the asymptotic solution with recent rocket observations indicates that the vertical eddy diffusion coefficient is about 10^7 cm^2 sec^{-1} with a tendency to decrease slightly in lower regions. The results also imply that the turbopause is generally higher than the homopause. The variations in eddy diffusion coefficient, temperature and solar fluxes can be invoked to explain the seasonal and solar cycle variations in the electron density in the F region. (auth) (UK)

33271 ARTIFICIAL RED AURORA. II. EFFECT OF COOLING ON EMISSION. Taylor, J. R. (Avco Corp., Wilmington, Mass.). J. Atmos. Terrest. Phys., 29: 771-8(June 1967).

In Part 1 of this study, a qualitative theoretical explanation was presented for the red 6300 Å and green 5577 Å atmospheric emissions from atomic oxygen, which were produced in the southern conjugate area by the July 9, 1962 nuclear blast. This explanation was based on the principal assumption of a time-independent temperature of the emitting air. Because of this, only a qualitative order of magnitude comparison between theory and data on intensity and emission time was presented. In the present paper cooling by radiation and thermal conduction is incorporated into the calculations described in Part 1. As a result a more detailed quantitative theoretical description of the emission time history is made. The results compare closely with available photometer data during the times when the majority of the energy has been emitted, if the radiation is assumed to originate from the upper F region. (auth) (UK)

33272 PHOTOELECTRONS AND THE MAGNETOSPHERE. Catchpoole, J. R. (Univ. of Queensland, Brisbane). J. Atmos. Terrest. Phys., 29: 701-7(June 1967).

An investigation was made of the possible contribution to the low-energy electron content of the magnetosphere by photoelectric processes in the upper atmosphere. Results have indicated both the energy spectra of the emergent electrons and also their pitch-angle distributions. The latter are of importance in determining the subsequent motion, especially with regard to the net flux and precipitation between conjugate points. (auth) (UK)

33273 EFFECTS OF MAGNETIC STORMS ON THE F2-LAYER OF THE IONOSPHERE NEAR THE BOUNDARY OF THE EQUATORIAL ZONE. Kotadia, K. M.; Jani, K. G. (Gujarat Univ., Ahmedabad, India). J. Atmos. Terrest. Phys., 29: 661-72(June 1967).

A study is made on the variations in critical frequency of the F2 layer at Baguio, very near the boundary of the F2 equatorial zone, both for some typical individual storms and collectively for 71 SC-type magnetic storms in the IGY–IGC period. It is found that the changes in f_0F2 at Baguio (16.4°N, 120.6°E; I = 19°N) are primarily governed by the local time of sudden commencement of the magnetic storm and the way it develops with time. The local seasonal conditions seem to show little influence. This finding is consistent with the results of earlier studies of f_0F2 data at other low-latitude and equatorial stations. In addition, it is found that significant changes in f_0F2 also occur just after the SC in the initial phase, i.e., even before the onset of the main phase of the storm. The SD variation of f_0F2 at Baguio is similar to that of an equatorial station but the Dst variation shows the characteristics of both a low-latitude and an equatorial station. (auth) (UK)

33274 IONOSPHERIC DRIFT MEASUREMENTS AT IBADAN DURING THE I.Q.S.Y. Morriss, R. W. (Univ. of Ibadan, Nigeria). J. Atmos. Terrest. Phys., 29: 651-60(June 1967).

The results of measurements made at Ibadan of the E–W component of the drift velocity of ionospheric irregularities are presented, both for the E and F regions, for the I.Q.S.Y. (1964–1965). There is a clear seasonal variation in the form of the diurnal variation; some features appear to have an annual variation, and some a semiannual. Both the regular variations and the irregular variations in the E and F regions are found to be closely correlated. From the few measurements on the E_s layer it appears that the drift velocity is slightly greater by day, and in the night the median behavior corresponds closely to that of the F region for the months May to August, but this may be because more observations are available for that period. The fluctuations in the values for the F region at a given hour from day to day are greater in the night than in the day, reaching a maximum at 21 hr (G.M.T.). (auth) (UK)

33275 THE EFFECT OF DIURNAL TEMPERATURE CHANGES ON THE F2-LAYER. Thomas, G. R.; Venables, F. H. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 29: 621-40(June 1967).

Time-varying solutions obtained for the F2 region continuity equation under conditions of thermal nonequilibrium. An isothermal model atmosphere is used and the continuity equation includes a movement term due to temperature variations of the neutral atmosphere. It is found that a decrease of electron temperature at sunset does not produce a "post-sunset" increase of electron density. The "seasonal anomaly" in F2-region electron densities also cannot be explained in terms of temperature variations. It is that variations of electron temperature are important in determining electron density, but the height of maximum electron density depends on variations of the neutral gas temperature. (auth) (UK)

33276 ARTIFICIAL RED AURORA. I. PHENOMENOLOGY AND ELECTRONIC EXCITATION. Taylor, J. R. (Avco Corp., Wilmington, Mass.); Gassmann, G. J.; Barrett, T. B. J. Atmos. Terrest. Phys., 29: 757-69(June 1967).

A theoretical analysis of the red glow created in the southern conjugate region by the atmospheric nuclear burst of July 9, 1962, is described. This investigation is based on photometer measurements, all-sky camera measurements, plus other material pub-

lished previously. Heavy charged particles from the north are assumed to be the carriers of energy which initiated the red glow. A mechanism by which this ion source was coupled to the red glow in the 300–500 km altitude regime is assumed energy transfer to ambient atoms and free electrons and subsequent electronic excitation of the 5577 Å and 6300 Å lines of atomic oxygen. This mechanism is investigated and it is concluded, on the basis of a comparison of the theoretical calculations with the data, that electronic excitation was probably the dominating glow-contributing source. This result is checked for consistency against the background of other information on nuclear effects. (auth) (UK)

33277 THE DIRECTION OF MOVEMENT OF F2 REGION PERTURBATIONS. Reddi, C. R.; Rao, B. R. (Andhra Univ., Waltair, India). Radio Electron. Eng., 34: 53-9(July 1967).

A new method is described for measuring the direction of movement of F2-region perturbations from the changes of phase path due to traveling ionospheric perturbations recorded at three closely spaced aerials. The results of the analysis using this method for 151 perturbations are presented. It is found that the direction of movement of perturbations with quasi-periods of about 15 minutes and maximum height changes of about 2 to 3 km is within 230 to 250° to the east of north at the low-latitude station, Waltair. The direction of movement of these perturbations was found to be independent of the time of day. (auth) (UK)

33278 THE PRODUCTION, DEACTIVATION, AND CHEMICAL REACTIONS OF O (^{1}D) ATOMS. McGrath, W. D.; McGarvey, J. J. (Army Natick Labs., Mass.). Planet. Space Sci., 15: 427-55(Mar. 1967).

The modes of production of ^{1}D oxygen atoms are described, with reference to laboratory studies and to the formation of the species in the upper atmosphere. A detailed review is given of the work carried out on the physical deactivation process $O(^1D) + M \rightarrow O(^3P) + M$, and in particular an attempt is made to assess the relative importance of molecular nitrogen and oxygen as the deactivating species M, a matter which is of special significance for the upper atmosphere. On the basis of presently available facts, some general conclusions are drawn regarding the most probable mechanisms for the transfer of electronic energy in the deactivation process. The participation of O(^{1}D) in chemical reactions is also discussed in detail and its reactivity compared with that of the ground state atom. (auth) (UK)

33279 PARTICLES TRAPPED IN THE POTENTIAL WELL BEHIND A MESOTHERMALLY MOVING SATELLITE. Liu, V. C. (Univ. of Michigan, Ann Arbor). Nature (London), 215: 127-8(July 8, 1967).

Evidence is presented that the presence of a negative potential valley in the near wake of a negatively charged satellite suggests the existence of a belt filled with oscillating particles. (auth)

33280 CHANGES OF THE EARTH'S MAGNETIC FIELD AND RADIOCARBON DATING. Bucha, V. (Czechoslovak Academy of Geophysics, Prague); Neustupny, E. Nature (London), 215: 261-3(July 15, 1967).

Carbon-14 originates in the upper layers of the atomsphere as a result of cosmic-ray action. Cosmic-ray flux depends on the intensity of the Earth's magnetic field, a decrease in intensity in general causing an increase of flux and hence also of ^{14}C. When the radiocarbon method of dating was discovered there were no reliable methods for investigating changes in the Earth's magnetic field and this led to incorrect results. Expressions are developed for calculating the rate of production of ^{14}C, including a function representing the change of the magnetic field with time, and deviations of true radiocarbon dates from historical values are indicated. (UK)

33281 EARLY MORNING EFFECT ON THE F-REGION FROM GROUND STATION OBSERVATIONS. Ilias, D.; Hatzopoulos, G. (National Observatory, Athens). J. Atmos. Terrest. Phys., 29: 749-55(June 1967).

Data from continuous vertical ionospheric recordings over Athens indicate that the morning effect on the F region regularly starts earlier than the f_0F2 predawn minimum as a rise of the virtual heights at fixed frequencies. The corresponding solar zenith angle undergoes a pronounced seasonal variation and presents a winter mean maximum value of 121°. The world-wide distribution of the predawn f_0F2 minimum, taken from the prediction maps, and the day to day variation over Athens are examined and the results discussed from the point of view of a possible magnetospheric contribution to the early morning phenomenon. (auth) (UK)

33282 RADIO REFLECTION BY FREE RADICALS IN EARTH'S ATMOSPHERE. Barry, J. Dale (Univ. of California, Los Angeles); Coleman, Paul J.; Libby, W. F.; Libby, L. Marshall. Science, 156: 1731-2(June 30, 1967).

Reflections of Mc radio signals by free radicals in the ionosphere were observed, having about the intensity predicted for induced magnetic-dipole transitions. It seems that magnetic atoms, ions, and molecules in planetary atmospheres may be detected by this method. These observations were made with the topside ionosonder of the Canadian satellite Alouette II. (auth)

33283 EVIDENCE FOR VELOCITY DISPERSION IN AURORAL ELECTRONS. Bryant, D. A.; Collin, H. L.; Courtier, G. M.; Johnstone, A. D. (SRC Radio and Space Research Station, Slough, Eng.). Nature, 215: 45-6(July 1, 1967).

The intensities of 10-keV and 4-keV electrons were measured from a sounding rocket launched into a post-breakup aurora. Pulsations in intensity were observed, with a period of about 4 sec. at both energies. The 10-keV pulsations occurred about 0.5 sec. earlier than those at 4 keV. These results could have been caused by temporal changes in electron intensity or by spatial structure in the path of the rocket. The pulsations were similar in shape to pulsations observed in auroral light intensity, and it is noted that electrons in the range 10 keV to 4 keV are important in the production of auroral light. If the pulsations are temporal in origin, the delay can be explained as a dispersion after simultaneous modulation 55,000 km from the rocket. The source of the modulation is near the point where the local magnetic field line crosses the geomagnetic equator. The equipment used in the rocket flights is described. Measurements were taken during 40 sec. while the rocket was near its apogee of 195 km. It is concluded that electrons responsible for the production of aurora can be significantly affected by processes occurring as far away as 55,000 km. The implication is that the route taken by the auroral electrons passes close to the geomagnetic equator at a distance of six Earth radii. (UK)

33284 PULSATING RADIO AURORAL ECHOES. Brooks, D. (PEL Auroral Station, Omakau, N. Z.). Nature, 215: 48-50 (July 1, 1967).

It has been found that the periods of repetition of radio auroral echoes are close to those predicted for the bounce periods of hydromagnetic waves along the geomagnetic line of force terminating in the echo region. This finding is discussed, and mechanisms examined. The bounce periods considered are those for waves having angular frequencies ω considerably less than Ω_e, the minimum (equatorial plane) particle cyclotron frequency along the field line. There can be an apparent agreement between echo period and hydromagnetic bounce period for $\omega \simeq 0$ up to $\omega \simeq 0.1\ \Omega_e$, beyond which the travel time increases as $\omega \rightarrow \Omega_e$. A possibility considered is that the pulsations arise from a resonant interaction of the type discussed by Wentzel (J. Geophys. Res. 66: 359 (1961)). Inspection of one of the auroral echo examples suggests that the beam may be composed of protons, since one of the echoes has a fine structure period of 24 sec., corresponding to a proton energy of 150 keV (for a proton mirroring at low altitude). The hydromagnetic wave frequency involved is 0.7 cps; micropulsations of this frequency have been reported. Trains of pulsations were observed with repetition periods of about 2 min. These observations can explain, at least qualitatively, the occurrence of pulsating auroral echoes. Trapping and precipitation of particles are discussed. The radar echoes are generally confined to the range interval 400 to 1,200 km, which involves that part of the magnetosphere between L = 3 and L = 4.5. The hydromagnetic mechanism appears to explain satisfactorily the production of pulsating auroral echoes, but it cannot account directly for observed pulsating electron precipitation. It is possible that these electrons are accelerated into the atmosphere by a space charge electric field set up when positive charge in the form of protons is removed from the magnetosphere. (UK)

33285 THERMAL HISTORY OF THE MOON. Ornatskaya, O. I.; Al'ber, Ya. I. (Gorky State Univ., USSR). Soviet Astron. AJ (Engl. Transl.), 11: 122-7(July-Aug. 1967).

Translated from Astron. Zh., 44: 158-65(Jan.-Feb. 1967).

The results of computations of the thermal regime of the moon during the time of its existence are given for different variants of content of radioactive elements; an electronic computer was used. The computations are made first for a uniform distribution of radioactive elements within the moon, and then for an exponential distribution with a different effective depth of their main concentration, for the purpose of calculating the migration of radioactive elements to the surface at the time of melting. The dependence of the effective depth of occurrence of radioactive elements and the present thickness of the solid crust on the concentration is clarified. Temporal dependences are derived for lunar temperature at different distances from the center and the heat flux through the lunar surface, and also for the present temperature distribution along the lunar radius for different variants of the concentration of radioactive elements. Some physical aspects of the thermal history of the moon are discussed. (auth)

33286 WHISTLER STUDY OF THE DISTRIBUTION OF THERMAL ELECTRONS IN THE MAGNETOSPHERE. Angerami, Jacyntho Jose. Stanford, Calif., Stanford Univ., 1966. 109p.
Thesis.

Whistlers are ulf radio signals produced by the dispersive propagation through the magnetosphere of electromagnetic energy from lightning discharges. Whistlers exhibiting a characteristic minimum in time delay are called "nose whistlers," and are especially useful in studying the magnetosphere. Previous whistler studies have shown that the electron density equatorial profile exhibits an abrupt decrease, or "knee," at a geocentric distance of about 4 earth radii. Nose whistlers recorded at Eights Station, in Antarctica, during the austral winter of 1963 were analyzed to provide detailed information on the electron density in the magnetosphere. This research produced two major results. First, experimental evidence was obtained in support of simple theoretical models to describe the field line distribution of ionization in the magnetosphere above a few thousand kilometers: a diffusive equilibrium model in the plasmasphere (inside the knee), and an idealized collisionless model, behaving approximately as R^{-4}, in the plasma trough (outside the knee). Second, by using the appropriate model in each of the two regions, details were obtained on the electron density in the vicinity of the knee. In particular, under conditions of steady and moderate geomagnetic activity ($K_p \sim 2-4$), it was found that: (1) During the post-midnight hours, the electron density in the equatorial plane at the knee (geocentric distance of approximately 4 earth radii) drops from ~300 electrons/cm^3 to ~5 electrons/cm^3 in not more than ~0.5 earth radii. The electron content in tubes of force (bounded by the 1000 km level and the equatorial plane) also shows a pronounced change: the tube-content drops from $\sim 20 \times 10^{12}$ electrons/cm^2-tube to 1.5×10^{12} electrons/cm^2-tube over a latitude range of ~0.5°. The whistler propagation in the plasma trough during the post-midnight hours is restricted to the vicinity of the knee. (2) During the afternoon, the knee (also at a geocentric distance of approximately 4 earth radii) involves a drop in equatorial density from ~300 electrons/cm^3 to ~15 electrons/cm^3, and a drop in electron tube-content from $\sim 20 \times 10^{12}$ electrons/cm^2-tube to $\sim 4 \times 10^{12}$ electrons/cm^2-tube. As on the nightside, the decrease appears to take place within a fraction of an earth radius, but details could not be studied because of an apparently double-valued profile. This condition is tentatively attributed to the combination of a longitude spread of paths in a multicomponent whistler and a corresponding longitude variation in knee position. The plasma trough in the dayside is probed by whistlers out to a geocentric distance of ~7.6 earth radii, where the equatorial density reaches ~0.5 electrons/cm^3. (Disser. Abstr.)

33287 INVESTIGATION OF SUDDEN FREQUENCY DEVIATIONS DUE TO THE IMMEDIATE IONOSPHERIC EFFECTS OF SOLAR FLARES. Donnelly, Richard Frank. Urbana, Ill., Univ. of Illinois, 1966. 163p.
Thesis.

Sudden frequency deviations (SFD) are events where the received carrier frequency of an hf radio wave reflected from the ionosphere increases suddenly for about one minute to a peak frequency deviation of usually less than 2 cps, and then decays back to the transmitter frequency. SFD's are caused by impulsive enhancements of the electron density in the ionosphere produced by bursts of x-ray and ultraviolet radiation from solar flares. This thesis investigates the intensity, wavelength, and time dependence of the solar radiation causing SFD's. Ionization loss processes, the preflare electron density profile, sporadic E, and other physical factors of the ionosphere are examined to determine their influence on SFD's. SFD's are studied by first considering several model x-ray flares that are consistent with satellite observations. The frequency deviations corresponding to these model flares are then computed for various representative solar zenith angles, preflare electron density profiles, and transmission frequencies. Then the SFD's and satellite observations of solar radiation are studied in detail for the following flare events: 19:35 U.T., April 19, 1962, the largest SFD observed at Boulder and the largest high-energy x-ray burst observed by OSO I; 20:00 U.T., April 20, 1962, one of the largest flare enhancements of He^{2+} (304 Å) line emission observed by OSO I; and 22:40 U.T., October 22, 1963, observed by the Vela satellites. SFD's are shown to be sensitive to impulsive bursts of ionizing radiation with rise times of several minutes or less. They are insensitive to radiation enhancements with rise times of tens of minutes. X-ray flares at wavelengths of 4 to 100 Å are sufficient to explain some SFD's, but important flare enhancements of ionizing radiation at wavelengths longer than 100 Å must occur during some solar flares. Observed flare enhancements of He^{2+}(304 Å) are large enough to be important to SFD's providing they are impulsive enough. The time resolution of satellite observations of extreme ultraviolet radiation has been inadequate for flare observations; no He^{2+}(304 Å) observations have been made during an SFD observed at Boulder. Lyman α enhancements and x-ray bursts observed at wavelengths less than 0.5 Å do not contribute significantly to SFD's. The ionization enhancements causing SFD's occur primarily in the E region and sometimes also in the F_1 region. Flare enhancements in the 0.5 to 4 Å range which are important to the more well-known types of ionospheric observations of flare events in the D region are at most of minor importance to SFD's. Recommendations for improving SFD observations and satellite observations of flare radiation are given. Further studies of SFD's are suggested. (Disser. Abstr.)

33288 MEASUREMENTS OF IONOSPHERIC CURRENTS. Maynard, Nelson Charles. Durham, N. H., Univ. of New Hampshire, 1966. 171p.
Thesis.

Eight Nike–Apache sounding rockets were instrumented to investigate the vertical current distribution of the equatorial electrojet over India and off the coast of Peru, to investigate the vertical current distributions of the S_q current system at low latitudes off the coast of Peru, to determine if the lunar current system is separate from, or part of, the S_q system, and to correlate these measurements with simultaneous electron density measurements. Four rockets were launched near the dip equator from the Thumba Equatorial Rocket Launching Site near Trivandrum, India. The other four were launched off the coast of Peru, two near the dip equator (UNH 65-4 and UNH 65-5) and two to the north (UNH 65-2 and UNH 65-3), from the USNS Croatan, as part of the NASA Mobile Launch Expedition. A proton magnetometer measured the magnetic field, and a simple D.C. Langmuir probe monitored electron density. A night flight over India (UNH 64-4) showed the effect of nighttime currents there to be less than 10 γ. Other flights into the electrojet from India (UNH 64-1, UNH 64-2, and UNH 64-3) and from Peru (UNH 65-4 and UNH 65-5) indicated that the electrojet is an intense layer of current centered about 109 km with a more diffuse tail extending to higher altitudes (130 km in India; 135 km in Peru). The vertical distribution is thicker and centered higher than that found in previous measurements. A second layer may exist, centered between 140 and 145 km near the center of the electrojet, although evidence is not conclusive. Taking into account the finite width of the electrojet, the ratio, in India, of the contribution of the ionospheric currents at the ground to the total change in magnetic field on the ground is approximately 2/3. Since no reverse currents were observed on the flights at the time of maximum negative effect of the lunar current system (UNH 64-3) and UNH 65-4), it appears that the lunar system is either a modulation of the normal current, or that it may exist at a higher altitude (unlikely because of lower conductivity). Maximums of electron density correlated with maximums of current density, although the reverse was not always evident. Evidence was found that the effect of the magnetic field on the Langmuir probe is dependent upon the length of the probe in the direction of the magnetic field. It was found that the low-latitude S_q currents can exist in two layers, one centered at 100 km and the other at 120 km (UNH 65-2). A reverse or negative current centered at the height of the maximum electrojet current (which may have been a return current from the electrojet) was observed to exist close to the electrojet (UNH 65-3). (Disser. Abstr.)

33289 ENERGY SPECTRUM OF AURORAL ZONE ELECTRON PRECIPITATION. Hudson, Hugh Steven. Berkeley, Calif., Univ. of California, 1966. 95p.
Thesis.

Measurements of the energy spectrum of x rays in the auroral zone were made from high-altitude balloons. The experimental parameters of the measurements were sufficiently well controlled to permit the deduction of the flux and spectrum of the electron precipitation in the range 20 to 100 keV. The daytime electron precipitation at geomagnetic latitude 64.5°N was found generally to obey an exponential energy distribution ($J(E) = e^{-E/E_0}$) with mean energy E_0 ranging from 10 to 50 keV. A diurnal pattern was found in the shape of the electron spectrum. The spectrum was independent of the intensity of the precipitation except during the presence of long-period pulsations. The spectrum information supports the interpretation of such pulsations as an effect of the coupling of hydromagnetic waves in the magnetosphere to energetic particle fluxes. The spectra of microbursts ($E_0 = 25$ keV) prove that microbursts are related to the pedestal fluxes coinciding with their occurrence. However, microburst episodes may not be related to the general diurnal precipitation. Other observations, at a geomagnetic latitude 69°N, demonstrated a relationship between nighttime precipitation over the polar cap and the fluxes of energetic electrons observed deep in the tail of the magnetosphere. (Disser. Abstr.)

Low-Temperature Physics

Refer also to abstracts 32289, 32315, 33369, 33537, 33538, and 33559.

33290 (COO-1112-114) PHOTO-EJECTION OF ELECTRONS FROM BUBBLE STATES IN LIQUID HELIUM(II). Northby, Jan Arwood (Minnesota Univ., Minneapolis). Dec. 1966. Contract AT(11-1)-1112. 158p. Dep. CFSTI.

Thesis.

Observation of the photoejection of electrons trapped in bubble states in liquid helium is reported. Detection of this effect offers very direct evidence of the validity of the bubble model. An electron which spends part of the time untrapped should have a higher average drift velocity in an electric field than one which remains in a bubble. A time-of-flight apparatus was used to detect changes in the drift velocity of electrons when they are exposed to radiation in the one-micron region. An effective cross section was measured as a function of light wavelength. The experimental curves are compared with cross sections calculated for spherical square wells of various depths and radii. If the current experimental value of the well depth is used agreement is obtained with theory if the bubble radius is either 14.90 ± 0.30 Å, or 20.55 ± 0.35 Å. These results are in reasonable agreement with previous theoretical and experimental estimates. The observed magnitude of the effect is also consistent with theory. (auth)

33291 (LA-3600) BOSE-EINSTEIN CONDENSATION AND SUPERCONDUCTIVITY. Gruenberg, Leonard W. (Los Alamos Scientific Lab., N. Mex.). Jan. 1967. Contract W-7405-eng-36. 47p. Dep. CFSTI.

The Bardeen-Cooper-Schrieffer theory of superconductivity is discussed with an emphasis on its similarity to the theory of Bose-Einstein condensation in a charged Bose gas. (auth)

33292 (LA-DC-8458) ON THE λ-ANOMALY IN HYDROGEN AND DEUTERIUM. Schuch, Adam F.; Mills, Robert L.; Depatie, David (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 14p. (CONF-670802-2). Dep. CFSTI.

From 12th International Congress of Refrigeration, Madrid, Spain.

It has been known for some time that in solid hydrogen rich with ortho molecules or in deuterium rich with para molecules the specific heat rises with decreasing temperature because of the ordering of the rotational states of these molecules. Later it was found that at a still lower temperature there is a sharp λ peak in the specific-heat curve. Others also observed anomalies in the nuclear magnetic resonance in this region. Recently a hexagonal-to-cubic phase transition was observed at these low temperatures. This transition in hydrogen and deuterium was studied as a function of the ortho-para ratio and of the temperature. It was found that the phase transition line coincides with the line of the λ anomaly of the thermal measurements and with the location of the anomalies in the nuclear magnetic resonance. It indicates that a crystal structure change is included in the cooperative ordering of the rotational states. These measurements were extended over a wider range of ortho-para ratios than have been studied in the thermal and nuclear magnetic resonance researches. A wide hysteresis in the hexagonal-cubic-hexagonal transitions was observed. (auth)

33293 (LA-DC-8463) SAFETY PROBLEMS AND SAFETY CODES CONCERNING LIQUID HYDROGEN AND LIQUID HELIUM. Edeskuty, F. J. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 36p. (CONF-670802-1). Dep. CFSTI.

From 12th International Congress of Refrigeration, Madrid, Spain.

Safety problems which occur in the storage and handling of liquid hydrogen and liquid helium include material selection, contamination, pressure relief and stress analysis. Proper material selection requires optimization of a number of factors, only one of which is the metal ductility at the use temperature. Consideration of temperature gradients during the cooldown process has shown that stress contributions from this source are important and must be included in the overall system stress analysis. Careful control must be exercised over contaminants since they can accumulate over a period of time which could result in line plugging or the formation of explosive or detonable mixtures. Safety codes are being developed for liquid hydrogen. Safety restrictions which exist cover shipping procedures, production purities, minimum distances between storage vessels and between storage vessels and other facilities. Distance standards are not necessarily uniform as this is an evolving technology. Significant experience to date with large quantities of liquid hydrogen permits a high level of confidence in the use of this material. (auth)

33294 SUPERCONDUCTIVITY OF LANTHANUM AND LANTHANUM COMPOUNDS AT ZERO AND HIGH PRESSURE. Smith, T. F.; Luo, H. L. (Univ. of California, San Diego). J. Phys. Chem. Solids, 28: 569-76(Apr. 1967).

The superconducting transition temperatures (T_c) of the compounds La_3Al, La_3Ga, LaZn, and $LaMg_2$ are reported. The pressure dependence of the T_c of a number of lanthanum compounds, for which the lanthanum is considered to play the dominant role in determining the occurrence of superconductivity, was also measured. The data obtained suggest a strong correlation between the La-La nearest neighbor atomic separation and the T_c, with a maximum T_c at an optimum separation of ~3.55 Å. (auth) (UK)

33295 CRITICAL SURFACE CURRENTS AND THE ANGULAR DEPENDENCE OF THE SURFACE CRITICAL FIELD OF A TYPE-II SUPERCONDUCTOR. Bellau, R. V. (General Electric Co. Ltd., Wembley, Eng.). Proc. Phys. Soc. (London), 91: 144-50 (May 1967).

Measurements of the critical surface currents above H_{c2} in a rectangular sample of a Ta-Nb alloy were made as a function of the magnitude of the applied magnetic field and its orientation with respect to the main surface plane. The results are similar to the corresponding data of Swartz and Hart (Phys. Rev., 137: 818-28(1965)); but the field dependence is different from, and the magnitudes are smaller than predicted by, the calculations of Abrikosov (Soviet Physics-JETP, 20: 480-8(1965)) and Park (Phys. Rev. Letters, 15: 320-5(1965)). By a simple analysis of the results, the angular dependence of the surface nucleation field was derived and is compared with theory. The reasons underlying the discrepancies between theory and experiment are discussed. Surface roughness is a factor having appreciable influence on the observed critical currents. (auth) (UK)

33296 ALMOST IDEAL BEHAVIOUR IN SOME TYPE-II SUPERCONDUCTING ALLOYS. French, R. A.; Lowell, J.; Mendelssohn, K. (Oxford Univ.). Cryogenics, 7: No. 2, 83-8 (Apr. 1967).

The magnetic and resistive properties of several alloys of niobium with tantalum and with molybdenum were found to be very close to those expected of an ideal superconductor of the second kind. The magnetization curves, measured by a variety of techniques, are almost completely reversible and the details are in good agreement with Abrikosov's (Zh. Eks. Teoret. Fiz., 32: 1442 (1957)) predictions. The mixed state thermal conductivity shows little hysteresis with respect to increasing and decreasing magnetic fields, in agreement with the magnetic measurements. Critical currents are very small, and the resistive behavior is very close to that expected of an ideal defect-free sample in which the mixed state voltages are determined by flux flow. (auth) (UK)

33297 MAGNETIZATION MEASUREMENTS OF SUPERCONDUCTING Mo-Re ALLOYS CONTAINING IRON. Barth, N.; Hoening, H. E.; Fulde, P. (Univ., Frankfurt am Main). Solid State Commun., 5: 459-61(1967).

A measurement of dM/dH near H_{c2} (the upper critical field) for a Mo-Re system with Fe impurities showed the different character of the two pairbreaking mechanisms involved. (auth) (UK)

33298 DEMAGNETIZATION CRYOSTAT FOR MOESSBAUER EFFECT EXPERIMENTS. Shinohara, Motoo; Ishigaki, Atsushi; Ono, Kazuo (Tokyo Univ.). Jap. J. Appl. Phys., 6: 982-90(Aug. 1967).

A demagnetization cryostat for use in Moessbauer effect experiments is described. Thermal contact of the paramagnetic salt with the liquid helium bath was established with a mechanical heat switch. 50 g of CrK alum was used as the refrigerant. Temperature of the alum reached 0.08°K after demagnetization and took 3 hours to rise to 0.3°K, the liquid helium bath being held at 1.8°K. The magnetic hyperfine structure of $FeCl_2 \cdot 4H_2O$ ($T_N \simeq 1$°K) has been observed by employing this cryostat. (auth)

33299 THE SPECIFIC HEAT AND SUPERCONDUCTIVITY OF La-Y ALLOYS. Satoh, Takeo; Ohtsuka, Taiichiro (Tokyo Univ.). J. Phys. Soc. Jap., 23: 9-18(July 1967). (NP-16691).

The low temperature specific heats of La-Y alloys were measured in order to investigate the origin of superconductivity in lanthanum. The addition of yttrium to lanthanum was found to result in a large decrease of the electronic specific heat coefficient γ, a decrease in the superconducting transition temperature T_c and a gradual increase of the Debye temperature θ_D. The rate of increase of θ_D in the yttrium-rich hcp phase was observed to be appreciably larger than in the α-La phase. The effective interaction derived from the BCS formula was found to remain approximately constant in the α-La phase followed by a rapid decrease in the hcp phase. From the general trend of the measured and derived quantities with alloying, it is suggested that the superconductivity of lanthanum may be closely related to mechanism leading to the depression of the Debye temperature and the stabilization of the α-La structure. This implies that phonon processes are of importance in the enhancement of superconductivity. (auth)

33300 ON THE NATURE OF CURRENT-INDUCED TRANSITIONS IN TYPE-II SUPERCONDUCTORS ABOVE H_{c2}. Bellau, R. V. (General Electric Co. Ltd., Wembley, Eng.). Solid State Commun., 5: 533-6(July 1967).

Measurements of the voltage–current characteristics in fixed magnetic fields, in the regime of the superconducting sheath, were made on sheet samples of a Ta–Nb alloy. The data for a given specimen fit a simple empirical expression whose form depends on the method of surface preparation. Surface roughness is suggested as the factor determining the functional form of the characteristics. (auth) (UK)

33301 CORRELATION BETWEEN CRITICAL CURRENTS AND CRITICAL MAGNETIC FIELDS IN A NONIDEAL TYPE-II SUPERCONDUCTOR. Leblanc, M. A. R.; Griffiths, D. J. (Univ. of Southern California, Los Angeles). Cryogenics, 7: 107-8(Apr. 1967).

It is reported that the critical current, I_{co}, in unannealed wires of 50Nb–50Ta appears to obey the modified Silsbee rule, $I_{co} = 5RH^*_{ci}$ (R being the wire radius in cm and H^*_{ci} corresponding to the peak magnetization). The form of the dependence of H^*_{ci} on the wire size and on the pinning force density is predicted. (UK)

33302 SKIN EFFECT IN A TYPE-II SUPERCONDUCTOR. Alais, P.; Simon, Y. (CNRS, Paris. Ecole Normale Superieure, Paris). Phys. Rev., 158: 426-32(June 10, 1967).

A single-crystal cylinder of Pb–2.6% In is placed in a dc magnetic field parallel to its axis, and a low-amplitude (1-mG to 1-G) low-frequency alternating field is superposed parallel to the dc field. Between H_{c1} and H_{c2}, a volume flux penetration into the sample is observed by means of a one-layer coil of 20-μ wire wound directly on the sample. When the excitation-field level is larger than a certain "threshold" value, the signal contains odd harmonics of the excitation frequency. Below this threshold, the flux penetration is linear with excitation field, as in the case of a normal metal, and can thus be described by an equivalent resistivity p. At the lowest excitation levels employed, no effect of a superconducting surface sheath was observed as though the critical surface currents were extremely small. Furthermore, above H_{c2}, as determined by the magnetization curve, the persistence of nonlinear effects suggests the existence of vortices, even when the total magnetization is found to be negligible. (auth)

33303 COUPLED SUPERCONDUCTING QUANTUM OSCILLATORS. Silver, A. H.; Zimmerman, J. E. (Ford Motor Co., Dearborn, Mich.). Phys. Rev., 158: 423-5(June 10, 1967).

Voltage biasing of a single superconducting weak link results in coherent electromagnetic oscillation at the frequency $\nu = V/\Phi_0$; simultaneous voltage biasing of two weak links in a superconducting ring produces two strongly coupled oscillators at the same frequency. The electromagnetic phase difference is the difference in the gauge-invariant quantum phases across the two contacts. Because of the quantization of the superconducting ring, this phase difference is $2\pi\langle\Phi\rangle/\Phi_0$, where $\langle\Phi\rangle$ is the time-averaged magnetic flux in the superconducting circuit and Φ_0 is the flux quantum. The coupled system can be characterized in terms of normal modes, and these modes of oscillation were experimentally observed at 30 MHz. This provides a means of understanding the earlier observations of quantum interference in the resistive state. (auth)

33304 MEASUREMENTS OF MAGNETIZATION IN SUPERCONDUCTIVE MOLYBDENUM. Mallon, Richard G.; Rorschach, H. E. Jr. (Rice Univ., Houston, Tex.). Phys. Rev., 158: 418-23 (June 10, 1967).

The magnetization curves of three samples of superconductive molybdenum were measured in a helium-3 cryostat for $0.40°K < T < T_c$, the critical temperature. The samples were single crystals obtained from two different sources. All three were prepared by electron-beam float-zone refining. Transition temperatures of the samples were 0.899, 0.903, and 0.906°K. The zero-temperature critical field was 98 G for all samples. The magnetization curves show that molybdenum is a type-I superconductor. Both supercooling and flux trapping were observed in the normal-to-superconductive transition. Most of the flux remaining in the sample following the transition disappeared linearly with the field as the applied field was lowered. The critical field was measured as a function of temperature and the results are compared with the BCS theory. (auth)

33305 TEMPERATURE AND PURITY DEPENDENCE OF THE SUPERCONDUCTING CRITICAL FIELD H_{c2}. IV. STRONG-COUPLING EFFECTS. Werthamer, N. R.; McMillan, W. L. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 158: 415-17 (June 10, 1967).

The existing theory of the transition temperature of a strong-phonon-coupling superconductor in zero magnetic field is merged with that of the upper critical field H_{c2} of a weak-coupling type-II superconductor to arrive at formulas for the strong-coupling corrections to $H_{c2}(T)$. A numerical computation is carried out for a phonon model of pure niobium. The strong-coupling effects make up only a negligible portion of the discrepancy between the earlier weak-coupling theory of H_{c2} and experimental observation, the remainder of which must be ascribed to Fermi-surface anisotropy. (auth)

33306 THERMAL CONDUCTIVITY OF PURE TYPE-II SUPERCONDUCTORS IN HIGH MAGNETIC FIELDS. Maki, Kazumi (Univ. of California, San Diego, La Jolla). Phys. Rev., 158: 397-9(June 10, 1967).

The electronic contribution to the thermal conductivity in a pure type-II superconductor in the gapless region (i.e., in a field close to the upper critical field H_{c2}) is obtained. Use is made of the fact that the order parameter is described by the Abrikosov solution of the Ginzburg-Landau equation and $l/\xi_0 \gg 1$, where l is the electronic mean free path and ξ_0 is the coherence distance. It is shown that the thermal conductivity drops rapidly in the superconducting region like $(H_{c2}-H)^{\frac{1}{2}}$, and is strongly anisotropic. (auth)

33307 EXISTENCE OF LONG-RANGE ORDER IN ONE AND TWO DIMENSIONS. Hohenberg, P. C. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 158: 383-6(June 10, 1967).

It is pointed out that a rigorous inequality first proved by Bogolyubov may be used to rule out the existence of quasi averages (or long-range order) in Bose and Fermi systems for one and two dimensions and $T \neq 0$. (auth)

33308 LAW OF CORRESPONDING STATES FOR fcc AND d-hcp LANTHANUM. Johnson, D. L.; Finnemore, D. K. (Ames Lab., Iowa). Contract W-7405-eng-42. Phys. Rev., 158: 376-82(June 10, 1967). (IS-1481).

The specific heats of fcc and d-hcp La have been measured from 1.0 to 10.0°K. There is a striking similarity between these two metals, and a law of corresponding states is obeyed for both the superconducting- and normal-state specific heats. An energy-gap parameter determined from both the temperature-dependent electronic specific heat and from the free-energy difference is $3.7kT_c$, in good agreement with the BCS value. No evidence is found for an f-band contribution to the superconducting characteristics. (auth)

33309 PARAMAGNETIC SUPERCONDUCTIVITY IN EXTREME TYPE-II SUPERCONDUCTORS. Hake, R. R. (North American Aviation Science Center, Thousand Oaks, Calif.). Phys. Rev., 158: 356-76(June 10, 1967).

Magnetization measurements in applied magnetic fields $0 < H \leq 55$ kG and at temperatures $1.2 \leq T \leq 4.2°K$ have been made on some extremely "dirty" (short electron mean free path) type-II superconducting transition-metal alloys with Gor'kov-Goodman-calculated Ginzburg-Landau κ_G values in the range 30–100: Ti(16 at. % Mo), V(30 at. % Ti)(10 at. % Cr), Ti(22.5 at. % V), and Ti(25 at. % V). Down to the lowest temperatures of measurement, the data show that the high-field superconducting mixed state of such materials is characterized by (a) reversible paramagnetic magnetization, (b) second-order transitions at upper critical fields $H_u(T)$ where the paramagnetic superconducting magnetization $M_s(H)$ becomes equal to the paramagnetic normal-state magnetization $M_n(H)$, and (c) parameters $\kappa_1(T) \equiv H_u(T)/[\sqrt{2}H_c(T)]$ (where $H_c \equiv$ the thermodynamic critical field) and $\kappa_2(T) \propto [d(M_s - M_n)/dH]^{-\frac{1}{2}}_{H_u}$ which decrease with decrease of T. The second-order nature of the upper-critical-field transition implies a mixed-state Pauli-paramagnetic conduction-electron spin alignment near $H_u(T)$ which is comparable to that in the high-field normal state. Comparison of the $H_u(T)$, $\kappa_1(T)$, and $\kappa_2(T)$ data with recent extreme type-II theories of Maki and of Werthamer, Helfand, and Hohenberg suggests that electronic spin-flip scattering induced by spin-orbit coupling effectively acts to decouple superconductive spin pairing and thus enhance mixed-state Pauli paramagnetism. (auth)

33310 MAGNETIC-FIELD-INDUCED SURFACE STATES IN A PURE TYPE-I SUPERCONDUCTOR. Pincus, P. (Univ. of California, Los Angeles). Phys. Rev., 158: 346-53(June 10, 1967).

The problem of a bulk pure type-I superconductor in a static magnetic field ($H < H_c$) applied parallel to the surface is considered. It is shown that there may exist single-particle excitations of energy (relative to the Fermi energy) less than the zero-field energy gap, which are spatially bound to the surface region where the screening current flows. The contribution of these localized states to the electromagnetic absorption of the superconductor at frequencies below the zero-field absorption edge (2Δ) is investigated. Order-of-magnitude estimates seem to be in agreement with the observations in aluminum by Budzinski and Garfunkel. (auth)

33311 FAR-INFRARED ABSORPTION IN SUPERCONDUCTING NIOBIUM ALLOYS. Cappelletti, R. L. (Univ. of Illinois.

Urbana); Ginsberg, D. M.; Hulm, J. K. Phys. Rev., 158: 340-5 (June 10, 1967).

Far-infrared measurements have been made to determine the superconducting energy gap widths in bulk samples of binary alloys in the system Zr–Nb–Mo. The variation of the gap width 2Δ with concentration is qualitatively similar to the variation of the critical temperature T_c. There is a marked variation in the BCS coupling constant V. The relation between $2\Delta/kT_c$ and V is opposite to that in the simple metals. (auth)

33312 BULK (H_{c2}) AND SURFACE (H_{c3}) NUCLEATION FIELDS OF STRONG-COUPLING SUPERCONDUCTING ALLOYS. Eilenberger, Gert; Ambegaokar, Vinay (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 158: 332-9(June 10, 1967).

The linearized self-consistency equation, in the electron–photon model, for the nucleation of superconductivity in the presence of a magnetic field is studied. It is found that near the transition temperature this integro-differential equation is susceptible to analysis. The main results are that the ratio of surface to bulk nucleation fields is predicted to have the weak-coupling value of 1.695, thus not confirming a recent experimental suggestion of a value near 1.9 for strong-coupling superconductors. The slope $(\partial H_{c3}/\partial T)_{T_c}$ is worked out both in terms of integrals over the parameters of the bulk-strong-coupling theory and in terms of other experimental quantities. Comparison of this last result with existing experiments on pure lead is attempted, with good success. In the Appendix an implicit equation for $H_{c2}(T)$ for all T is derived, but the numerical work necessary to solve this equation has not been undertaken. (auth)

33313 TUNNELING INTO SUPERCONDUCTING FILMS IN A MAGNETIC FIELD. Millstein, J.; Tinkham, M. (Univ. of California, Berkeley). Phys. Rev., 158: 325-32(June 10, 1967).

Tunneling experiments were performed on thin superconducting films in the presence of a magnetic field. The experiments were done at ^{3}He temperatures on tin and tin-indium alloy films with thicknesses between 600 and 2000 Å. As expected theoretically, the effect of the field on the density of states is, for dirty films, similar to the effect of paramagnetic impurities with the square of the magnetic field playing a role analogous to the paramagnetic impurity concentration. The data are compared with the theoretical results of Maki for the limit of zero mean free path, and agreement is fair. The difference between these results and those of this experiment is attributed to the finite mean free path. Strässler and Wyder have calculated the field dependence of the density of states for small particles with arbitrary mean free path. It is found that their calculations are in good agreement with experiment. (auth)

33314 EFFECT OF THE MEAN FREE PATH ON THE MAGNETIC BEHAVIOR OF SMALL SUPERCONDUCTING PARTICLES. Straessler, S.; Wyder, P. (Univ. of California, Berkeley). Phys. Rev., 158: 319-25(June 10, 1967).

The density of states of superconducting spheres much smaller in size than the coherence length ξ_0 and the penetration depth λ for arbitrary mean free path l and arbitrary fields at zero temperature was calculated. In agreement with experimental results, the theory predicts an appreciable deviation from results obtained in the limit $l \to 0$ even if the ratio l/ξ_0 is small, like $l/\xi_0 \simeq 0.1$. The dependence of the critical field on the mean free path and the boundary condition for arbitrary temperatures is discussed. (auth)

33315 COLLECTIVE EXCITATIONS OF A GRANULAR SUPERCONDUCTOR IN THE PRESENCE OF A STEADY UNIFORM CURRENT FLOW. Parmenter, R. H. (Univ. of Arizona, Tucson). Phys. Rev., 158: 314-18(June 10, 1967).

By a suitable linearization of the isospin equations of motion, a calculation is made of the collective excitations of a granular superconductor in the presence of a steady, uniform current flow. Aside from the case of vanishing frequency or wave vector, only collective excitations with wave vectors perpendicular to the direction of current flow can occur physically (all others violating the condition of electric charge neutrality in the superconductor). This ensures that the uniform supercurrent is stable against decay by excitation of collective oscillations (excitations bounded in space and time). Those excitations which can occur in the presence of the steady, uniform current are appreciably modified by the latter. (auth)

33316 OPTICAL BIREFRINGENCE AND CRYSTAL GROWTH OF HEXAGONAL-CLOSE-PACKED ^{4}He FROM SUPERFLUID HELIUM. Heybey, O. W.; Lee, D. M. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 19: 106-8(July 17, 1967).

Crystals of solid helium (on the order of 2 cm^3) were grown by slowly increasing the pressure over superfluid He to slightly above the freezing pressure. Evidence is presented that many of these crystals were single crystals. Measurements were made of the difference in the indices of refraction of extraordinary and ordinary light in solid hcp ^{4}He at temperatures between 1.2 and 1.4°K and pressures between 25.0 and 26.0 atm. A value of $n_e - n_o = (2.6 \pm 0.1) \times 10^{-6}$ was obtained. (A.G.W.)

33317 RELATION BETWEEN CURRENT AND VOLTAGE IN TYPE-II SUPERCONDUCTORS IN THE FLUX-FLOW REGIME. Cladis, P. E. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 19: 116-18(July 17, 1967).

It has been found that the relation $\ln I \propto V^{\frac{1}{2}}$ accurately describes flux flow in superconductors in both the linear and nonlinear portions of the I–V curves. The validity of this relation is sample independent. (auth)

33318 SUPERCONDUCTIVE PAIRING ACROSS ELECTRON BARRIERS. Cohen, Morrel H.; Douglass, D. H. Jr. (Univ. of Chicago). Phys. Rev. Lett., 19: 118-21(July 17, 1967).

The possibility of superconductive pairing of two electrons separated by a barrier is considered. It is argued that such pairing is possible in principle for all metals and may lead to high transition temperatures. (auth)

33319 EFFECT OF DIELECTRIC AND HIGH-RESISTIVITY BARRIERS ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF THIN FILMS. Strongin, M. (Brookhaven National Lab., Upton, N. Y.); Kammerer, O. F.; Douglass, D. H. Jr.; Cohen, Morrel H. Contract AT(30-2)-Gen-16. Phys. Rev. Lett., 19: 121-5(July 17, 1967). (BNL-11434).

Increases in the transition temperature of a structure consisting of alternate 60-Å layers of superconductor S and barrier material B are observed whenever the sequence SBS is formed. The effect was observed for Al, Zn, In, Sn, and Pb and for a variety of barrier materials. (auth)

33320 PARALLEL FIELD DEPENDENCE OF VORTEX PINNING IN SUPERCONDUCTING FILMS. Deltour, R.; Tinkham, M. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett., 19: 125-7(July 17, 1967).

The experimentally measured influence of the parallel component of the magnetic field on the depinning threshold of vortices in superconducting films is related directly to the reduction of the square of the Ginzburg–Landau order parameter. (auth)

33321 FERMION IMPURITIES IN A WEAKLY INTERACTING BOSE GAS. Lange, Yvonne (Brandeis Univ., Waltham, Mass.). Proc. Phys. Soc. (London), 91: 177-86(May 1967).

The Green function is derived for a small concentration of fermions in a weakly interacting Bose gas using mass operator perturbation theory. For small momentum it is found that the spectral weight function of the system consists of a quasiparticle peak associated with an effective mass m^*, as well as some weight at higher energies. The momentum dependence of both parts of th spectral weight function is determined. The implications of the weight at higher energies in the case of dilute ^{3}He–^{4}He mixtures are discussed. (auth) (UK)

33322 A CRYOSTAT AND SUPERCONDUCTING MAGNET SYSTEM FOR EXPERIMENTS IN HIGH MAGNETIC FIELDS BETWEEN 1 AND 300°K. Meaden, G. T.; Pelloux-Gervais, P. (Univ., Grenoble, France). Cryogenics, 7: 93-5(Apr. 1967).

A cryostat with an anti-dewar arrangement, a superconducting magnet, and a metal dewar and liquid helium transfer siphon are described. With this system, measurements on physical properties can be carried out within steady high magnetic fields at temperatures between 1°K and ambient. Permanently sited within the double walls of the metal dewar is one limb of the liquid helium siphon. This ensures that when filling the dewar liquid helium enters the inner part of the dewar directly at its base and therefore beneath the superconducting solenoid and calorimeter. Such a scheme, called a dewar-wall siphon, allows for efficient cooling of the contents of the dewar by the liquid helium and its rising vapor. The apparatus has been used for experiments on the Hall effect and magnetoresistivity of metals. (auth) (UK)

33323 CURRENT OSCILLATION IN THE COMPOSITE SUPERCONDUCTING CABLE MODEL. Ihara, Seijiro; Kaiho, Katsuyuki (Electrotechnical Lab., Tokyo). Jap. J. Appl. Phys., 6: 1022-3(Aug. 1967).

The question of whether current can be shared by a normal conductor in parallel with a superconductor while the superconductor stays in the superconducting state was studied, using niobium–zirconium wire and copper wire. (M.O.W.)

33324 SOME THERMODYNAMIC INVESTIGATIONS INTO LIQUID NEON ISOTOPE MIXTURES. Gladun, C. (Institut Tieftemperaturphysik, Dresden). Cryogenics, 7: 78-80(Apr. 1967).

Based on measurements of specific heat at constant volume, of density, and of the thermal pressure coefficient of liquid neon, isotherms are calculated, and the behavior of specific heat as a function of the molar volume is discussed. By determining the

values of specific heat in the two-phase system, the specific heat at constant pressure and along the boiling line is calculated. The influence of isotopic composition on the specific heat, and on the density, are investigated by measurements of a neon isotopic mixture concentrated with 80% ^{22}Ne. (auth) (UK)

33325 DISTRIBUTION OF MAGNETIC FIELDS AND CURRENTS IN TYPE-II SUPERCONDUCTORS. Coffey, H. T. (Westinghouse Research Labs., Pittsburgh). Cryogenics, 7: 73-7(Apr. 1967).

Direct measurements were made of the distribution of the magnetic field gap between two closely spaced type-II superconducting rods axially located in a superconducting solenoid. From the gradient of the magnetic field the induced current density was obtained as a function of position along the diameter of the rods. The data were plotted on an X–Y recorder and clearly show the manner in which the field penetrates the samples at various field intensities including flux jumping and flux flow. Comparisons are made between the observed and predicted forms of field penetration. The general behavior is described by the relation $j(B + B_0) = \alpha$ suggested by Kim and Anderson, [Rev. Mod. Phys., 36: 39 (1964)] although local deviations caused by inhomogeneities in the samples are present. Field measurements were made with a vacuum-deposited bismuth Hall probe having a resolution of $\sim 10^{-4}$ cm^2. (auth) (UK)

33326 LOSSES OF SUPERCONDUCTING NIOBIUM IN LOW-FREQUENCY FIELDS. Rocher, Y. A.; Septfonds, J. Cryogenics, 7: 96-102(Apr. 1967).

Losses in superconducting niobium samples subjected to alternating magnetic fields of frequencies ranging from 500 to 10,000 cps were measured. The dependence of losses upon the following factors was investigated: frequency and strength of the ac field, strength of an applied static field, surface roughness, trapped flux, electrical conductivity, and reversibility of magnetization. Losses were minimized by electropolishing the niobium surface and cooling the samples in the absence of magnetic field. Outgassing resulted in an increase of the losses in the absence of static field but led to an appreciable decrease in the presence of a static field somewhat lower than H_{c1}. Losses appear to have two different origins: local flux penetration leads to losses that vary linearly with frequency; flux line motion leads to nonhysteretic power losses. (auth) (UK)

33327 EFFECT OF TRAPPED FLUX ON RF SUPERCONDUCTING LOSSES. Victor, J. M.; Persyn, G. A.; Rollwitz, W. L. (Southwest Research Inst., San Antonio). Cryogenics, 7: 119 (Apr. 1967).

Preliminary results are reported showing the effect on rf residual losses in 5-mil niobium wire attributed to trapped flux (resulting from cooling fields up to 60 gauss). Fields as low as the earth's field (~0.5 gauss) can cause rf losses larger than the surface resistance losses below 200 Mc. (UK)

33328 PRODUCTION OF VERY LOW TEMPERATURES WITH THE DENSE PHASES OF ^3He. Goldstein, Louis (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 159: 120-35(July 5, 1967). (LA-DC-8306).

The melting anomaly of ^3He enables one to produce very low temperatures through adiabatic solidification. Exchange effects in the solid are expected to prevent the reaching of temperatures very much below the one defined by the exchange-energy parameter, where the melting anomaly should cease. Relaxation-time measurements in the solid define this parameter within the limitations of the assumed exchange-interaction scheme, as well as of those of the formalism that connects the coupling scheme with the relaxation times. With the empirical exchange parameter, the entropy of the solid at melting can be obtained down to quite low temperatures. This entropy combined with that of the liquid, available from an earlier theory of this phase, enables one to calculate the melting-pressure line, essentially from fundamentals. The agreement between the theoretical melting-pressure line and the available data at low and medium temperatures is satisfactory. The theoretical melting line has an inflection point, outside the range of measurements, due to the magnetic ordering process imposed by the assumed interaction scheme. The most promising way of verifying this prediction, at temperatures well above the ordering temperature, appears to be through the observation of the crossing of the heat-capacity curves of the liquid and solid at or near melting. The theoretical entropies of the two phases suggest that in starting with liquid ^3He at saturation and at an easily accessible temperature, adiabatic compression alone ensures, in principle, the reaching of quite low temperatures. This process is discussed in detail, and its use toward reaching temperatures in the millidegree range will be described. An analysis of the thermal anomalies of low-pressure solid ^3He due to the assumed exchange coupling will be presented. At melting these anomalies should extend up to near 0.25°K. The solid at and near melting is shown to exhibit a narrow entropy wedge over a fairly wide pressure range around the melting-line minimum. With its spin entropy being practically complete at 0.1°K, solid ^3He should have very small derivative thermal properties, expansion coefficient, and heat capacity over a fairly wide temperature and pressure range. The expansion coefficient at or near melting is estimated to vanish, and to become negative, somewhat below 0.25°K. This technically difficult region of the thermal properties extends down to a few hundredths of a degree, below which the thermal anomalies of the low-pressure solid should increase rapidly to become more accessible to observations and measurements. (auth)

33329 THEORY OF THE MELTING ANOMALY OF ^4He. Goldstein, Louis; Mills, Robert L. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 159: 136-45(July 5, 1967). (LA-DC-8585).

The melting anomaly of ^4He predicted earlier is accounted for in detail by two different methods. In the first or thermodynamic approach, the thermal properties of the liquid and solid at melting are used to evaluate the temperature derivative of the melting pressure and the ensuing difference between the melting pressure at temperature T and absolute zero. In the second method, these same melting-pressure functions are derived theoretically from the elementary excitation spectra of the liquid. In the elaboration of the latter approach, the thermal properties of liquid ^4He II, arising from the approximate high-energy branch of its elementary excitations, are given exactly. Both methods yield similar results in quantitative agreement with recent melting-pressure data over most of the region explored. (auth)

33330 PROPERTIES OF AN EXCESS ELECTRON IN LIQUID HELIUM: THE EFFECT OF PRESSURE ON THE PROPERTIES OF THE NEGATIVE ION. Springett, B. E.; Cohen, Morrel H.; Jortner, Joshua (Univ. of Chicago). Phys. Rev., 159: 183-90 (July 5, 1967).

The Wigner–Seitz model formerly used to calculate the adiabatic barrier to electron penetration of liquid helium is applied to the study of the bubble model for a localized electron in liquid helium. Calculations of the pressure dependence of the radius of the negative ion agree with the experimental results to within an atomic radius in liquid helium. Comparison is made with other methods, and predictions regarding further properties of the negative ion are presented. (auth)

33331 VORTEX STRUCTURE IN SUPERCONDUCTING FILMS IN A PARALLEL FIELD. Kulik, I. O. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz., 52: 1632-7(June 1967). (In Russian).

It is shown that in a certain range of thickness (exceeding the coherence radius $\xi(T) \sim \hbar v_0/\Delta(T)$, but less than the penetration depth $\delta(T)$) a one-dimensional vortex structure of current and magnetic field distribution arises in superconducting films (the magnetic field being parallel to the surface). The possibility of observing such a structure by means of optical diffraction is discussed. (auth)

33332 DYNAMICS OF A SUPERFLUID FERMI GAS AT FINITE TEMPERATURES. Kemoklidze, M. P.; Pitaevskii, L. P. (Inst. of Physics Problems, Moscow). Zh. Eksp. Teor. Fiz., 52: 1556-69(June 1967). (In Russian).

The Keldysh diagram technique for nonstationary processes at finite temperatures is extended to the case of a superfluid Fermi system. An equation for a gap Δ varying in space and time is derived in the linear approximation. An expression for the elementary excitation energies is derived with an accuracy to the second space derivatives of Δ. A set consisting of the kinetic equation and an equation for the gap is derived for Δ slowly varying in space and time. In the quasi-classical approximation the equation set is the same as the Khalatnikov set for a superfluid Bose fluid. (auth)

33333 EFFECTIVE COORDINATE-SPACE POTENTIAL BETWEEN ^3He ATOMS IN SUPERFLUID ^4He. Campbell, L. J. (Univ. of Illinois, Urbana). Phys. Rev. Lett., 19: 156-9(July 24, 1967).

Starting from the helium interatomic potential for isolated atoms and the difference between the volume per atom of ^3He and ^4He in solution, an effective ^3He–^3He interaction is derived and used to calculate the solution properties (specific heat, magnetic susceptibility, ^3He "sound velocity," spin diffusion, thermal conductivity, viscosity, and maximum solubility) for small concentrations of ^3He. (auth)

33334 THEORY OF FLUX MOTION IN NONIDEAL TYPE-II SUPERCONDUCTORS. Irie, Fujio; Yamafuji, Kaoru (Kyushu Univ., Fukuoka). J. Phys. Soc. Jap., 23: 255-68(Aug. 1967).

A phenomenological expression of the pinning force density is proposed, and the equation of force balance including this expression is shown to describe well the motion of magnetic fluxoids in non-ideal type-II superconductors in cooperation with the equation describing the continuity of magnetic flux flow. The parameters related to an individual pinning force and pin distribution are included in the present expression which contains those from the models of Bean-London, Silcox-Rollins and Yasukōchi as its special cases. The calculated magnetizations agree well with observed data by adjusting the parameters. The hysteresis losses in the course of magnetization are calculated and the field dependence of the ac losses is explained. The formulas of the ac dynamic losses are also shown. The field dependence of the critical current in the resistive state and the relaxation time of flux penetration are calculated and compared with observed data. (auth)

33335 THERMAL PROPERTIES OF ANOMALOUS SUPERCONDUCTORS. Geilikman, B. T.; Kresin, V. Z. (Moscow State Extension Pedagogical Inst.). JETP Lett. (USSR) (Engl. Transl.), 5: 220-23(Apr. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redakt., 5: 271-4 (Apr. 1967).

The ratio $\Delta(o)/T_k$ and other characteristics of anomalous superconductors have been calculated numerically and analytically on the basis of the troehlich model, which takes direct account of the interaction of the electrons with the lattice. The jump of the specific heat on going from the superconducting to the normal state and the behavior of the thermal conductivity near T_k for superconductors with strong coupling are considered. (W.D.M.)

33336 QUANTUM STATES AND TRANSITIONS IN WEAKLY CONNECTED SUPERCONDUCTING RINGS. Silver, A. H.; Zimmerman, J. E. (Ford Motor Co., Dearborn, Mich.). Phys. Rev., 157: 317-41(May 10, 1967).

The results are presented of an experimental and phenomenological investigation of the static and dynamic behavior of weakly connected superconducting rings. The configuration is essentially a macroscopic superconducting ring of inductance L incorporating a point contact as a weak link which determines the critical supercurrent in the ring, i_c. A phenomenological model for the stationary quantum states of the system as a function of an applied field is developed. The dynamic behavior is obtained directly from the time dependence of the applied fields. Experiments demonstrating both the stationary and the time-dependent magnetic behavior are described. The stationary behavior was obtained with a magnetometer incorporating a weakly connected ring as a sensor to measure the flux through the ring under test. The experimental results confirm the phenomenological model if the critical current i_c is greater than $\Phi_0/2L(1+\gamma)$, where $\Phi_0 = h/2e$ is the flux quantum and γ is a material and geometric parameter which is usually small compared to unity. In the regime $Li_0 > \Phi_0/2(1+\gamma)$, the quantum states are discrete, and the transitions between states are well defined and irreversible. If the critical current is not too large, the transitions generally occur only between adjacent states; that is, $\Delta k = \pm 1$. At large critical current, multiple quantum jumps are observed. On the other hand, if $Li_c < \Phi_0/2(1+\gamma)$, the quantum states merge into one another continuously and reversibly. In this case the magnetic behavior in the neighborhood of the half-quantum points is related to the depairing or gapless regime in superconductivity. Measurements of the ac properties of the weakly connected ring at 30 MHz are interpreted directly in terms of the static properties under the influence of a time-varying applied field. In fact, no qualitative corrections to the theory are expected up to frequencies of the order of the superconducting energy gap. (auth)

33337 ULTRASONIC ATTENUATION IN DIRTY SUPERCONDUCTORS. McLean, F. B.; Houghton, A. (Brown Univ., Providence). Phys. Rev., 157: 350-7(May 10, 1967).

The attenuation coefficients of acoustic waves have been calculated for small-gap superconductors for the case where the electron mean free path l is much smaller than the pure superconductor coherence length ξ_0. Emphasis is placed on a study of longitudinal acoustic waves. It is shown that attenuation in this case arises from both electromagnetic absorption and the collision drag effect. In the transverse case the electromagnetic absorption is negligible in the low-frequency limit $|\Delta|/\omega \gg 1$. The results of the calculation have been applied to the Abrikosov mixed state and the superconducting surface sheath. Measurement of the attenuation in these regimes will determine the upper critical fields H_{c2} and H_{c3} as well as the averaged amplitude of the energy gap. (auth)

33338 INTRINSIC SIZE EFFECTS IN TYPE-II SUPERCONDUCTING FILMS. Joseph, A. S. (North American Aviation Science Center, Thousand Oaks, Calif.); Tomasch, W. J.; Fink, H. J. Phys. Rev., 157: 315-17(May 10, 1967).

Null-deflection torque-magnetometer measurements performed on well-annealed low-κ type-II superconducting films in nearly parallel magnetic fields suggest that flux entry may be delayed to a field H_s which can be greater than H_{c_1}. It is found that H_s depends on the film thickness, the coherence length, and κ. Furthermore, results indicate that in films having a thickness less than 20 coherence lengths, two critical fields H_s and H_{c3} are observed, but not H_{c2}. The Arbikosov mixed state may be therefore suppressed in favor of a new state which resembles a giant vortex. Such a state is magnetically hysteretic and has been postulated by a recent theory. (auth)

33339 THE MOMENTUM DISTRIBUTION IN LIQUID HELIUM. Parry, W. E.; Rathbone, C. R. (Oxford Univ.). Proc. Phys. Soc. (London), 91: 273-8(June 1967).

A calculation is reported of the momentum distribution in liquid helium at absolute zero using a pair wave function and a modified superposition approximation. A value of 0.13 for the fraction of particles in the zero-momentum state is obtained. The approximations for the momentum distribution function for small values of k are shown to be inaccurate. The use of an exact result for n_ϵ for small k leads to a modified distribution function which gives 0.25 for the fraction of particles in the zero-momentum state. (auth) (UK)

33340 SUPERCONDUCTIVITY IN THE PRESENCE OF MAGNETIC EXCHANGE FIELDS. Crow, J. E.; Guertin, R. P.; Parks, R. D. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 19: 77-81(July 10, 1967).

The upper-critical field behavior of type-II superconductors in the presence of strong magnetic exchange fields is reported. In regimes where the exchange fields are temperature-dependent, the critical field displays a nonmonotonic dependence on temperature as predicted by de Gennes and Sarma. (auth)

33341 ELECTROMAGNETIC SHEAR-WAVE INTERACTION IN A SUPERCONDUCTOR. Fossheim, K. (Univ. of Maryland, College Park). Phys. Rev. Lett., 19: 81-5(July 10, 1967).

Expressions for the electromagnetic part of the interaction between electrons and shear waves in a superconductor are developed in the case where the electronic mean free path is long compared with the wavelength. Also, accurate measurements on the turnoff of electromagnetic interaction between electrons and transverse phonons near the superconducting transition temperature of a metal are presented. (T.S.S.)

33342 SOUND IN A DEGENERATE SOLUTION OF ^{3}He IN SUPERFLUID HELIUM. Khalatnikov, I. M. (Inst. of Theoretical Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 5: 235-8(Apr. 15, 1967).

Translated from Zh. Eksp. Teoret. Fiz., Pis'ma Redakt., 5: 288-91(Apr. 15, 1967).

It is known that solutions of ^{3}He in ^{4}He become stratified at temperatures below 0.8°K. At $T \to 0$, one end of the stratification curve lies at the point of pure matter (^{3}He), and the other at the point corresponding to a solution with concentration of approximately 6%. When $T \ll T_{deg} = m^*v_F^2/2$ one has a degenerate solution in a superfluid. The properties of sound in a degenerate solution near absolute zero are considered when the collisions of the impurity excitations are unimportant. In this case the excitation distribution function satisfies a kinetic equation with zero collision integral. (W.D.M.)

33343 HEAT CURRENTS IN LIQUID HELIUM II: TEMPERATURE AND VELOCITY FIELDS IN LARGE CHANNELS. Ricci, M. V.; Vicentini-Missoni, M. (Univ., Rome). Phys. Rev., 158: 153-61(June 5, 1967).

A detailed study of the distribution of normal fluid velocity and temperature in a large channel has been made. For very low heat input, the normal fluid velocity is constant along the flow direction in agreement with the linear theory of the two-fluid model. However, for large heat input values, anomalous distributions with large gradients confined to restricted space regions are observed both for the velocity and the temperature. The transition between the two flow regimes is seen to correspond to a critical superfluid velocity which is temperature-independent in the range 0.88 to 1.92°K. The supercritical flow is then interpreted as due to the presence of vorticity in the superfluid. (auth)

33344 SINGLE-COLLISION-TIME THEORY OF SOUND PROPAGATION IN LIQUID ^{4}He BELOW 0.6°K. Disatnik, Yehiel (Univ. of Illinois, Urbana). Phys. Rev., 158: 162-9(June 5, 1967).

A unified derivation of expressions for the velocity and the attenuation of sound in liquid ^{4}He at $T < 0.6$°K is presented. The derivation, which is valid for both the hydrodynamic and the collisionless regions, is carried out within the framework of the simple conserving collision-time model. It is shown that using

this model one can reproduce the results obtained by Khalatnikov and Chernikova under the assumption of the existence of an equilibrium of collinear phonons. Since applying the collision-time approximation does not involve any assumption of this kind, it is argued that the assumption is in fact unnecessary. The theoretical derivation is accompanied by a discussion of the experimental results obtained by Abraham et. al. for the attenuation of collisionless sound. Special emphasis is placed on the effects of scattering of phonons from boundaries. It is shown on the basis of these results that the parameter γ which determines the dispersion of the phonon spectrum is likely to be smaller than 2×10^{35} g^{-2} cm^{-2} sec^2. (auth)

33345 PHENOMENOLOGICAL THEORY OF THE λ TRANSITION IN ^{4}He. Lee, K. C.; Puff, R. D. (Univ. of Washington, Seattle). Phys. Rev., 158: 170-5(June 5, 1967).

It is shown that a certain set of phenomenological statements about fluctuations near the λ line yields a consistent picture of thermodynamic derivatives in the vicinity of this line. On the basis of this phenomenological description, one is able to predict properties near the λ line and compare these with experiments. (auth)

33346 ULTRASONIC VELOCITY AND DISPERSION IN LIQUID HELIUM II FROM 0.15 TO 1.8°K. Whitney, W. M. (California Inst. of Tech., Pasadena); Chase, C. E. Phys. Rev., 158: 200-14(June 5, 1967).

From the measurement of changes in the delay experienced by an ultrasonic pulse traversing a fixed path, the temperature dependence of the velocity of sound in liquid helium under its saturated vapor pressure has been determined from 0.15 to 1.8°K at the frequencies 1.00, 3.91, and 11.9 Mc/sec. A phase-comparison technique made it possible to resolve velocity changes amounting to a few mm/sec. With increasing temperature, the velocity u_1 increases above its asymptotic limit u_{10} at 0°K, passes through a maximum near 0.7°K, and decreases rapidly at higher temperatures. The velocity difference over any temperature interval that extends from below 0.2 to above 1.1°K is independent of frequency, but within the temperature range indicated u_1 increases with frequency and the position of its maximum shifts to higher temperatures. At (1.00, 3.91, 11.9) Mc/sec the maximum velocity lies (5, 7, 14) cm/sec above u_{10} and occurs at (0.65, 0.70, 0.72)°K. The dispersion is greatest in the neighborhood of 0.9°K, where the attenuation coefficient goes through a maximum. Within experimental error, the theory of Khalatnikov and Chernikova accounts for the separation between the velocity-versus-temperature curves at the three frequencies. Combination of the velocity changes measured in these experiments with values of the absolute velocity obtained by other workers above 1°K yields $u_{10} = 238.3_0 \pm 0.1_3$ m/sec. (auth)

33347 DYNAMICS OF THE MAGNETIZATION OF A THIN-WALLED SUPERCONDUCTING CYLINDER IN A PARALLEL FIELD. van Ooijen, D. J. Philips Res. Rep., 22: 219-32(June 1967).

The dynamics of the penetration of an applied parallel magnetic field into a hollow superconducting cylinder have been studied by measurement of the voltage fluctuations on a 4-kc resonant circuit that was magnetically coupled to the cylinder. On samples with appropriate wall thickness the field was found to penetrate as a random stream of individual flux quanta ϕ_0 in a temperature region down to 0.7°K below T_c. The value of ϕ_0 as determined from the fluctuations agrees with the theoretical value h/2e. Flux quantization has been demonstrated to occur at least up to 3.7×10^6 enclosed quanta ϕ_0. If the wall thickness d is smaller than the penetration depth λ, a dynamic flux quantum is found that is equal to $(d/\lambda)\phi_0$. Such quanta are found to enter in groups of two or three. (auth)

33348 FAR INFRARED STUDY OF THIN SUPERCONDUCTING LEAD FILMS. Palmer, Leigh Hunt. Berkeley, Calif., Univ. of California, 1966. 56p.

Thesis.

Ginsberg and Tinkham found an anomalous absorption of electromagnetic radiation below the energy gap in superconducting thin lead films. This absorption, often called the "precursor" absorption, suggested some unknown type of low lying excitation in the superconducting state. An investigation was made of the region from 9 to 120 cm^{-1} by measuring simultaneously the transmission and reflection of thin lead films, enabling one to infer the optical constants of the film without recourse to dispersion theory. A well-defined energy gap was observed at 2°K of 22.5 ± 0.5 cm^{-1}, corresponding to 4.5 ± 0.1 kT_c, where k is the Boltzmann constant and T_c is the superconducting transition temperature. No precursor was found of the strength reported in earlier work in the upper third of the gap. The frequency and temperature dependence of the real part of the conductivity fits the theory of Mattis and Bardeen very well. It was found that the temperature dependence of the energy gap agrees well with the Bardeen–Cooper–Schrieffer theory. (Disser. Abstr.)

33349 ZERO-FIELD NUCLEAR RELAXATION IN SUPERCONDUCTING ALUMINUM. MacLaughlin, Douglas Earl. Berkeley, Calif., Univ. of California, 1966. 118p.

Thesis.

Several field-cycling nuclear relaxation experiments were carried out in normal and superconducting bulk aluminum. A nuclear spin polarization is produced in a large magnetic field, while relaxation takes place in zero field. The nuclear order (or, equivalently, the inverse spin temperature) averaged over the sample is measured after remagnetization by conventional pulse techniques. Audiofrequency (af) absorption by the nuclear spins was observed in the superconducting state, from 0.56 to 1.2°K. The af field and time dependence of this absorption indicate that it occurs in the London penetration region. Deviations from an exponential field penetration function are less than ±10%. The magnitude of the absorption indicates that the nuclear order is concentrated in a sheath of thickness $\sim 10^{-5}$ to 10^{-4} cm near the surface of the sample. Flux expulsion during demagnetization causes the loss of nuclear order in the bulk of the sample, and the ordered sheath of surface spins is due to nearly adiabatic field changes during surface nucleation of the superconducting phase. The reduced thickness of the ordered sheath, in units of the penetration depth λ(T), increases with increasing temperature except for an anomalous decrease near the transition temperature T_c. The size of the nuclear signal recovered from the sheath shows no such decrease. The cause of the anomaly is uncertain. Evidence is presented which points to the movement of trapped flux, driven by the af field. Other experiments were concerned with details of zero-field spin–spin and spin–lattice relaxation. The spin–spin relaxation function at zero field was measured by a sudden (non-adiabatic) demagnetization technique, and found to vary by less than 2.5% between 0.51 and 1.35°K. A deviation from exponentiality of the spin-lattice relaxation function, observed by Hebel and attributed to conduction electron rearrangements around impurities, decreases in the superconducting state. (Disser. Abstr.)

33350 THE SOLID–LIQUID PHASE TRANSITION IN ^{3}He–^{4}He MIXTURES BELOW 1°K. Tedrow, Paul Muller. Ithaca, N. Y., Cornell Univ., 1966. 100p.

Thesis.

Investigations of the liquid–solid phase transition in ^{3}He–^{4}He mixtures at pressures up to about 30 atmospheres and temperatures from about 0.15 to 1°K using a strain gauge technique show that the mixtures, like the pure substances, have minima in their freezing curves as plotted on a pressure–temperature (P–T) diagram. Also, the mixtures can exist in the solid phase at lower pressures than can either pure substance. In addition, at the lower temperatures, two types of concentration-independent behavior were noted and are interpreted in terms of two three-phase equilibrium surfaces. When projected onto the P–T plane, one of these surfaces has a negative slope while the other has a positive slope. The intersection of these surfaces has been measured and implies the existence of a quadruple point. A three-dimensional P–T–X (pressure–temperature–concentration) phase diagram has been constructed incorporating these results together with the findings of other groups relating to the liquid phase separation and solid phase separation in the mixtures, and the crystallographic transition between hexagonal close-packed (hcp) and body-centered cubic (bcc) structures in the solid mixtures and in pure ^{4}He. Data from specific heat and nuclear magnetic resonance (NMR) measurements support the interpretation of the strain gauge results. (Disser. Abstr.)

33351 ROTATION OF HELIUM II IN AN ANNULAR CHANNEL. Masson, Bruce Stewart. Berkeley, Calif., Univ. of California, 1966. 105p.

Thesis.

The distribution of Onsager–Feynman vortices in a rotating annular channel of helium II is investigated by means of the free-energy model developed by Kemoklidze and Khalatnikov. The asymptotic solution of the Euler–Lagrange equation is achieved for the condition that the quantum of line circulation is small compared to the circulation of the inner cylinder. From the asymptotic solution, it can be concluded that the discontinuous vorticity profiles in no way approximate the behavior of the actual minimizing continuous vorticity profiles. And those continuous profiles displaying an annular zone free of vortices all possess higher free energies than associated with a uniform line density. Thus, the assumption of annular vortex-free zones, mixed with zones simulating solid-body rotation, leads to mathematically discontinuous vortex line densities that must be rejected on physical grounds. Continuous profiles containing vortex-free zones must be rejected on energy grounds. Thus, it is to be

expected that vortex lines exist across the channel. This result confirms a similar conclusion for a hard sphere Bose gas. (TSS) (Disser. Abstr.)

33352 GREEN'S FUNCTIONS AND SUPERFLUID HELIUM. PART I. GREEN'S FUNCTIONS AND SUPERFLUID HYDRODYNAMICS. PART II. LONG RANGE ORDER IN SUPERFLUID HELIUM. Kane, Joseph William. Urbana, Ill., Univ. of Illinois, 1966. 109p.

Thesis.

The two-fluid hydrodynamics of Landau and Tisza are related to the thermodynamic Green's function formulation of the many body problem. A specific approximation for the self energies yields the superfluid hydrodynamics in the limit of slow space and time variation. The approximation chosen is the simplest possible form for the self energies which include the effect of collisions and which also satisfy the differential conservation laws for mass, momentum, and energy. Of course these self energies are not adequate for a realistic description of ^{4}He. Nonetheless the structure of this model provides some insight into the exact theory. For example, in the model employed here the self energies and Green's functions obey several integral identities which are utilized in the derivation of the two fluid hydrodynamics, and which yield useful expressions for some thermodynamic quantities. It is speculated that the identities and the consequent expressions for the various thermodynamic quantities may have a wider range of validity than indicated in their derivation. At low temperatures, when the system contains well-defined elementary excitations, the Boltzmann equation reduces to the kinetic equation of Khalatnikov. This reduction is valid when the system is only slightly disturbed from local equilibrium. The conservation equations for the momentum and energy of the quasi particles are also obtained. The asymptotic behavior of the equilibrium single particle Green's function $G(\mathbf{r}-\mathbf{r}',t)$ is investigated for $|\mathbf{r}-\mathbf{r}'| \to \infty$. Correlated fluctuations appear in the phase of the wave function, and these correlations are analyzed using a cumulant expansion. The first term in the expansion can be computed exactly in the long wavelength limit, using the superfluid velocity correlation function obtained by Hohenberg and Martin. Higher order terms are estimated using dimensional arguments. Long range order does appear in the three dimensional boson system, however it is suggested that long-range correlations will not appear in the one and two dimensional systems. The discussion of the convergence of the series in two dimensions is particularly delicate, and the analysis here should not be considered conclusive. (Disser. Abstr.)

33353 THERMAL, ELECTRICAL, AND MAGNETIC PROPERTIES OF SUPERCONDUCTING Mo–Re ALLOYS. Lerner, Eugenio. Columbus, Ohio, Ohio State Univ., 1966. 114p.

Thesis.

Details are given of the research carried out on the low temperature properties of Mo–Re alloys in the superconducting and normal states. Measurements were made on a variety of Mo–Re alloys in various states of anneal, the alloys being in the form of fine wires suitable for the winding of high-field superconducting solenoids. Micrograph studies were made to determine the percentage of the various phases present in each specimen. The low temperature measurements covered observations on the various specimens of the electrical resistivity as a function of temperature and of magnetic field, of the thermal conductivity also as a function of temperature and of magnetic field, and of the magnetization as a function of applied magnetic field at various temperatures using two different techniques. The measurements yielded evaluations of the four critical magnetic fields, H_{c1}, H_{c1}, H_c, and H_{c3}, as a function of temperature and alloy constitution, the transition temperatures T_c, and the Ginzburg–Landau–Abrikosov–Gor'kov–Maki (GLAGM) parameters κ. Detailed comparisons of the results are made with theoretical predictions and with results by previous authors on similar high-field superconducting alloys. (Disser. Abstr.)

33354 INVESTIGATION OF THE SPECIFIC HEAT OF HELIUM IN THE NEIGHBORHOOD OF THE CRITICAL POINT. Moldover, Michael Robert. Stanford, Calif., Stanford Univ., 1966. 81p.

Thesis.

An apparatus has been constructed to measure the specific heat at constant volume (C_v) of ^{4}He and ^{3}He at various densities with high temperature resolution. Particular attention has been paid to measurements near the critical temperature (T_c) of the liquid–gas phase transition. Precautions were taken to minimize the effects of the long thermal relaxation time of a fluid near its critical point. The principal results are: 1. For temperatures in the range 10^{-3} °K < $T_c - T < 10^{-1}$ °K one may represent C_v of ^{4}He($T_c = 5.2$°K) at a density within 1% of the critical density by the dimensionless expression $(C_v/R) = -0.60 \ln [1 - (T/T_c)] + 2.0$. Over a similar temperature range one may represent C_v of ^{3}He($T_c = 3.2$°K) at a density of 0.97^5 of the critical density by the expression $(C_v/R = -0.37 \ln [1 - (T/T_c)] + 1.7$. This logarithmic divergence of C_v as the critical temperature is approached from below is similar to that observed in argon and suggests that in this respect real fluids behave like lattice gas models. 2. The coefficient of the logarithmic term in C_v decreases from Ar to ^{4}He to ^{3}He in accord with the qualitative prediction of Yang and Yang. This indicates quantum corrections to a lattice gas model are necessary to account for the reduced magnitude of the singularity in C_v in helium relative to that in the other noble gas. The numerical value of the coefficient of the logarithm in ^{4}He is equal within the combined experimental errors to the corresponding coefficient in the specific heat singularity at the λ point of ^{4}He. 3. The critical temperature of ^{4}He is found to be 5.189°K, considerably below the accepted value 5.199°K. This supports the idea that near the critical point the coexistence curve of ^{4}He has a nonanalytic form. 4. Above the critical temperature C_v of both ^{4}He and ^{3}He near the critical density cannot be well represented by either a logarithmic divergence or a simple power law over as wide a temperature range (10^{-3} °K < $T - T_c < 10^{-1}$ °K) as the logarithmic divergence extends below the critical temperature. It seems unlikely that C_v approaches a finite constant as $T \to T_c^+$. 5. In the two-phase region the temperature dependence of the functions d^2P/dT^2 (P is the saturated vapor pressure) and $d^2\mu/dT^2$ (μ is the chemical potential) may be found from specific data. Over the temperature range 10^{-2} °K < $T_c - T < 0.2$°K, d^2P/dT^2 for ^{4}He is increasing. Over the same temperature range $d^2\mu/dT^2$ does not go to zero. The latter conflicts with the result of the two dimensional lattice gas model where $d^2\mu/dT^2 \equiv 0$, indicating the model is too specialized in this respect. (Disser. Abstr.)

33355 ION MOBILITY IN LIQUID ^{3}He BELOW 1°K. Kuchnir, Moyses. Urbana, Ill., Univ. of Illinois, 1966. 104p.

Thesis.

The low field mobility of positive and negative ions in liquid ^{3}He was measured for temperatures between 0.03°K and 1°K and pressures of 27.9 atm, 7.5 atm, and less than 0.35 atm. Ions in the liquid were produced by a radioactive tritiated titanium source and their mobility was obtained by directly measuring their drift velocity using a time of flight technique which involved a multigrid system of electrodes. Details of the experimental procedures as well as of the experimental apparatus and its construction are given. The positive ion mobility, μ_+, was found to be larger than the negative, μ_-, except at 27.9 atm above 0.3°K, where both are $\approx$0.036 cm^2/V sec. By increasing the pressure, μ_- was observed to increase while μ_+ decreased. Furthermore, μ_- was found to be a continuous function of the temperature, reproducible within 1% throughout the entire temperature range of the measurements, while μ_+ presented hysteresis in a temperature range that depended on the pressure. The experimental results are presented in both graph and table forms. Some typical mobility values are given. The systematic error involved in the absolute value of the mobility is less than 10%. The "cluster" model for the positive ion and the "bubble" model for the negative ion in liquid helium are discussed in some detail and applied for liquid ^{3}He. The temperature and pressure dependence of μ_- between 0.03°K and 0.07°K is in agreement with the theoretical prediction for the mobility of an electron localized in a bubble that undergoes Brownian motion in a Fermi gas. No theoretical calculation available predicts μ_- between 0.07°K and 1°K or μ_+ correctly. (Disser. Abstr.)

33356 LOW-TEMPERATURE SPECIFIC HEAT OF Sn AND Sn–In ALLOYS. Wilkes, William Roy. Urbana, Ill., Univ. of Illinois, 1966. 92p.

Thesis.

The normal state specific heats of pure tin and alloys consisting of 0.5, 1, 2, 4, and 6 at. % indium were measured between about 0.4 and 4.2°K. All of the alloys lie within the solid solubility limit of indium in tin. Measurements were made in an adiabatic calorimeter cooled by a ^{3}He refrigerator, with the specimens magnetically quenched from the superconducting state. Additional cooling of some specimens was possible by adiabatic magnetization to achieve temperatures as low as 0.24°K. The results for pure tin are compared with recent data for the temperature coefficient of the normal electronic specific heat, γ, and the Debye temperature, θ. The results for the alloys are interpreted in terms of the variation in γ and θ, and comparisons are made with recent determinations of the variations of γ and θ with increasing indium concentration. While the variation of θ is in reasonable agreement with reported values, the variation of γ with increasing indium content is positive, in disagreement with previously reported data. The results are also discussed in the light of the theories of Markowitz and Kadanoff and of Ginsberg on the variation of the critical temperatures of superconductors with alloying. (Disser. Abstr.)

33357 ELECTROMAGNETIC PROPERTIES OF SUPERCONDUCTORS. Lucas, Gary LeRoy. New Haven, Yale Univ., 1966. 110p.

Thesis.

Some of the most important and interesting unsolved problems in the theory of superconductivity are connected with the dynamical properties of superconductors. The linear response of a superconductor to time varying electromagnetic fields is considered. The investigation is based on the very successful theory of superconductivity developed by Bardeen, Cooper and Schrieffer. General gauge invariant expressions are attained for the induced charge and current densities both in clean (long mean free path) and dirty (short mean free path) superconductors. The scattering is assumed to arise from a random distribution of nonmagnetic impurities. Various limiting cases, appropriate for type-II superconductors, of the response functions are obtained. The results are interpreted and compared with existing theories, e.g., two-fluid model. The results will also be useful for a discussion of fluctuations in the superconducting state. (Disser. Abstr.)

33358 AN EXPERIMENTAL STUDY OF MASS TRANSPORT THROUGH THE HELIUM II FILM. Glick, Forrest Irving. Minneapolis, Univ. of Minnesota, 1966. 117p.

Thesis.

Measurements of mass transport rates for flow of liquid helium through the He(II) film have been made in an apparatus in which the film flow took place between an inner reservoir and an outer reservoir held at constant temperature. The reservoirs were separated by a stainless steel vacuum jacket. The height of the rim of the vacuum jacket above the equilibrium liquid level in the reservoirs, referred to as the barrier height, h_0, could be varied from 3 to 30 cm. Measurements under adiabatic conditions were made with the inner reservoir thermally isolated from the outer reservoir by seating a plug into the top of the vacuum jacket. With the plug raised isothermal conditions were maintained through the gas phase. Flow rates were inferred by monitoring the liquid level in the inner reservoir with a capacitor depth gauge. The measured values of the specific entropy deficit of the superfluid component of the helium, determined from the rise of the inner liquid level when the film was driven thermally at unsaturated transfer rates, agreed within ±4% with accepted values of the specific bulk entropy in the temperature range 1.27 to 2.02°K. Adiabatic and isothermal oscillations of the liquid levels were studied. Film profiles of the form $d = kh^{-n}$ were inferred from the dependence of the isothermal oscillation frequency on h_0 for $h_0 > 4$ cm. k lay in the range (10.2 to 14.0) × 10^{-8} cm and n lay in the range (0.50 to 0.63). Damping of the oscillations was accounted for phenomenologically by adding to the equation of motion the damping term, $2\dot{z}/\delta$, where z is the liquid level difference between the two reservoirs. For $h_0 < 13$ cm the isothermal logarithmic damping decrement was approximately constant; for larger h_0 it increased and appeared structured. The damping at each h_0 increased as the temperature increased. Isothermal gravitational and saturated adiabatic transfer rates were found to be nearly independent of h_0 for 4 cm < h_0 < 20 cm, the isothermal rates being 10 to 15% smaller than the adiabatic rates. An approximate T^6 dependence was found for the effective thermal conduction coefficient between the reservoirs in the adiabatic experiments. Measurements of the ratio of z to the temperature difference between the reservoirs under adiabatic conditions agreed with theoretical predictions within experimental error. (Disser. Abstr.)

33359 NEW SIZE-DEPENDENT OSCILLATORY MAGNETORESISTANCE EFFECT IN GALLIUM AT LOW TEMPERATURES. Munarin, Joseph Anthony. Evanston, Ill., Northwestern Univ., 1966. 121p.

Thesis.

The nonmonotonic (oscillating) part of the magnetoresistance in six, very pure, oriented single crystals of gallium was measured at 1.2°K in the range 0 to 16 kG, using the audio-frequency field modulation technique. A new size-dependent oscillatory component was found in the transverse magnetoresistance of both b-type and c-type samples (current parallel to the b and c crystallographic axes, respectively), similar to the Sondheimer effect previously found in sodium, aluminum, and cadmium. The oscillations grow in magnitude with H in the indicated range, which is shown to extend well into the high field region $\omega\tau > 1$, rather than damping as a negative power of the magnetic field as expected. The strongest effects were found in the region adjoining the a axis, and a Fourier analysis of the data for the 1-mm-thick sample shows that five frequency terms are present within the range 11.6 to 12.6 kG^{-1}, corresponding to periods of 79 to 86 gauss for H||a. A detailed analysis of the frequency spectrum in several b- and c-type samples with rectangular, square, and circular cross section is given. The relationship between the frequency of the oscillations and sample geometry for the rectangular c-type samples is found to be $F = g(\theta)\, d_a \sec\theta$ for $\theta < \theta_0$ and $F = g(\theta)\, d_b \csc\theta$ for $\theta > \theta_0$, where d_a and d_b are the dimensions of the crystal and θ measures the inclination of the magnetic field to the a axis. The angle θ_0 corresponds to H parallel to the diagonal of the cross section, and $g(\theta)$ depends only upon the shape of the Fermi surface. It is shown that the oscillations may be consistently interpreted on the basis of a modified OPW (single orthogonalized plane wave) model of the Fermi surface. Theoretical results of Bloomfield are quoted which show that the oscillations are larger relative to the Sondheimer (spherical) case by a factor of H^2 at high fields, and the fluctuations in the resistivity asymptotically approach a constant amplitude in the same limit. (TSS) (Disser. Abstr.)

Plasma and Thermonuclear Physics

For abstracts of individual chapters see: 33365–33368, 33396–33402, 33469, and 33479–33481.

33360 (CONF-670104–Pt.1) PROCEEDINGS OF CONFERENCE ON PHYSICS OF QUIESCENT PLASMAS, FRASCATI, JANUARY 10–13, 1967. PART I. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratorio Gas Ionizzati). Feb. 1967. 302p. Dep.

Separate abstracts were prepared for 15 of the 22 included papers. For abstracts of the remaining papers see CONF-670104 in the report number index. (M.O.W.)

33361 (MATT-Q–24) ANNUAL REPORT, JANUARY 1–DECEMBER 31, 1966. (Princeton Univ., N. J. Plasma Physics Lab.). May 1967. Contract AT(30-1)-1238. 467p. Dep. CFSTI.

Separate abstracts were prepared for the 3 main sections. (M.O.W.)

For abstracts of individual sections see: 33362, 33363, and 33369.

33362 (MATT-Q–24, pp 197-334) THEORY. (Princeton Univ., N. J. Plasma Physics Lab.).

Brief summaries of plasma research are given on equilibrium and stability and general plasma theory. (M.O.W.)

33363 (MATT-Q–24, pp 1-195) EXPERIMENTAL WORK. (Princeton Univ., N. J. Plasma Physics Lab.).

Various research summaries of experimental work on stellarators, multipoles, Q machines, and other miscellaneous studies are presented. Results are presented for many of the topics. (M.O.W.)

33364 (SU-SEL–67-020) [PROGRESS ON PLASMA PHYSICS, RADIOSCIENCE, SOLID-STATE ELECTRONICS, SYSTEMS TECHNIQUES, AND SYSTEMS THEORY]. Quarterly Status Report No. 105, January 1–March 31, 1967. (Stanford Univ., Calif. Stanford Electronics Labs.). Contract Nonr-225(83). 96p.

Brief summaries of research are presented for each of the following areas: plasma physics, radioscience, solid-state electronics, systems techniques, and systems theory. (M.O.W.)

Confinement and Heating of Plasma

33365 (CONF-670104–Pt.1, pp 223-34) DIFFUSION PLASMA IN THE EXPERIMENTS DAPHNIS I AND DAPHNIS II. Bernard, M.; Briffod, G.; Gregoire, M.; Weisse, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

Experiments were performed in order to produce a dense and quiescent plasma to investigate diffusion of particles across the magnetic lines. The results of the measurements are described. (M.O.W.)

33366 (CONF-670104–Pt.1, pp 235-42) INFLUENCE OF A RADIAL ELECTRIC FIELD UPON THE RADIAL DIFFUSION OF A MAGNETICALLY CONFINED CESIUM PLASMA. Berkl, E.; Grieger, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)).

In a homogeneous magnetic field a Cs plasma is produced by contact ionization on a small tantalum surface and a plasma column is formed by plasma motion parallel to B (similar to a Q machine in single-ended operation). The application of a sufficiently large radial electric field leads to a transition to a different process of radial plasma transport, yielding a considerably increased plasma loss rate. This loss rate can be described by applying Bohm's diffusion coefficient. Simultaneously with the onset of the "enhanced diffusion" an increase in the plasma noise level is observed. (auth)

33367 (CONF-670104–Pt.1, pp 243-58) DIRECT MEASUREMENT OF THE CONFINEMENT TIME OF CESIUM PLASMA IN A Q DEVICE. von Goeler, S.; Motley, R. W. Princeton Univ., N. J. Plasma Physics Lab.).

The confinement time of a plasma in a Q machine has been measured by observing the decay of plasma density after the atomic beam producing the plasma has been shut off. At high density the main loss appears to be end plate recombination. At low densities anomalous losses occur. (M.O.W.)

33368 (CONF-670104-Pt.1, pp 259-70) DIFFUSION MEASUREMENTS IN POTASSIUM MAGNETOPLASMAS. Rogers, K. C.; Courville, G. E.; Wolf, N. S. (Stevens Inst. of Tech., Hoboken, N. J.).

Measurements are reported of $D_\perp$ based on the volume plasma loss properties of a variable length, single-ended linear Q device. The experiment is designed to avoid complications arising from end-plate processes and ion loss to radially inserted probes. Measurements were carried out both under quiescent conditions and in the presence of low-frequency microinstabilities with plasma potential fluctuations ≈kT. (M.O.W.)

33369 (MATT-Q-24, pp 335-448) ENGINEERING AND DEVELOPMENT. (Princeton Univ., N. J. Plasma Physics Lab.).

Brief summaries of engineering developments for plasma research are presented for the following areas: magnetic fields, electronic instrumentation, power electronics, power engineering, and systems. (M.O.W.)

33370 (NP-tr-1535) MAGNETIC ION INJECTION CHANNEL. Bezbatchenko, A. L.; Sadovskii, E. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated for U.K.A.E.A., Culham Lab., Abingdon, Eng.), from report IAE-1099. 17p. (CTO-371). Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

A magnetic channel for injecting hydrogen ions with energies to 160 keV into a magnetic field up to 3,500 Oe in "Ogra" through an angle between 0 and 35° to the plane perpendicular to the axis of the trap is described. It consists essentially of a bent steel tube of rectangular cross section, and fitted with a compensating and a deflecting coil. It can be heated to 400°C together with the vacuum vessel. (auth)

33371 DIRECT MEASUREMENT OF THE CONFINEMENT TIME OF CESIUM PLASMA IN A Q-DEVICE. von Goeler, S.; Motley, R. W. (Princeton Univ., N. J.). Phys. Fluids, 10: 1360-2(June 1967). (MATT-483).

The confinement time of a plasma in a Q machine has been measured by observing the decay of plasma density after the atomic beam producing the plasma has been shut off. At high density the main loss appears to be end plate recombination. At low densities anomalous losses occur. (auth)

33372 LEAKAGE PROBLEM IN FUSION REACTORS. Chen, Francis F. Sci. Amer., 217: 76-88(July 1967).

The various theories for plasma confinement in magnetic trap are discussed in relation to instabilities. The problems of confinement are discussed in a general manner. (M.O.W.)

33373 INSULATION OF PLASMA IN "TOKAMAK" INSTALLATION. Artsimovich, L. A.; Bobrovskii, G. A.; Mirnov, S. V.; Razumova, K. A.; Strelkov, V. S. At. Energ. (USSR), 22: 259-64 (Apr. 1967). (In Russian).

The size of the so-called time of retention of the energy in the plasma τ_E can be used as a measurement of the efficiency of the thermal insulation of the plasma in the "Tokamak" installation. The value τ_E calculated by measurement of the diamagnetic signals for different discharge regimes in two installations with substantially different dimensions are reported. It was shown that during a large part of the discharge the lifetime essentially exceeds that calculated by the Bohm formula. The substantial difference of the values of the electron temperature calculated by measurement of the diamagnetic signals and by the electric conductivity was discovered. (tr-auth)

33374 COMPUTER SIMULATION OF ANOMALOUS PLASMA DIFFUSION AND THE NUMERICAL SOLUTION OF POISSON'S EQUATION. Hockney, Roger Willis. Stanford, Calif., Stanford Univ., 1966. 200p.

Thesis.

The diffusion of a collisionless plasma across a constant magnetic field was studied by means of a two-dimensional Lagrangian computer model. This model represents the plasma by means of approximately 1000 charged rods and calculates their motion, stepwise in time, as they move according to the laws of Newton and Maxwell. The model is quasi-electrostatic and takes 1.7 sec to perform a time-step on the IBM 7090 computer. To check the validity of the model, the Vlasov equation is solved numerically for the steady state, taking into account the precise size of the Larmor radii. The results agree reasonably well with the model. The stability has been analyzed using the simplest-possible fluid equations; two unstable waves are predicted, with slightly different wave velocities, which beat together to give phase and amplitude variations strikingly similar to those observed. The calculated growth rates of these instabilities also agree very well. However, such a linear analysis cannot give the wave amplitudes or the amount of diffusion, both of which come out naturally in the computer model. (TSS) (Disser. Abstr.)

Diagnostics of Plasma

Refer also to abstract 32554.

33375 (INR-789/XVIII/PP) DETERMINATION OF ELECTRON DENSITY IN NONTHERMAL PLASMAS FROM THE INTENSITY RATIO OF TWO SPECTRAL LINES OF ION N_V. Suckewer, Szymon (Institute of Nuclear Research, Warsaw (Poland)). 1967. 12p. Dep.

The method of determination of electron density in nonthermal plasmas, based on the measurements of ratios of two lines intensities of a given ion is presented. It was also shown, that from the relative intensities of three chosen lines of the given ion it is possible to determine the electron density N_e and temperature kT_e of nonthermal plasmas. The populations densities of the levels 2^2P, 3^2P and 3^2D of ion N_V were considered and the plots for determination N_e and kT_e from the ratios of lines intensities of this ion were given. (auth)

33376 INVESTIGATION OF A SUPERSONIC RAREFIED ARGON PLASMA JET. Gol'dfarb, V. M.; Il'ina, E. V.; Kostygova, I. E.; Luk'yanov, G. A.; Silant'ev, V. A. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 111-16(Jan.-Feb. 1967). (In Russian).

The parameters of a supersonic argon plasma jet, expelled from a plasmatron nozzle into vacuum, are studied experimentally. The equipment used consisted of a gas vortex, stabilized dc plasmatron, a vacuum chamber, a sensor switching device, a condenser coil, and an ISP-51 spectrograph. The test conditions were as follows: a vacuum-chamber pressure of 2 to 4 N/m^2, a plasmatron arc-chamber pressure of (4 to 5) × 10^4 N/m^2, a mean-mass enthalpy of 12 × 10^6 joule/kg, and a critical nozzle cross section of 2.75 mm. The total-pressure distribution along the jet axis was measured by Pitot tubes, over a range of arc-chamber temperatures. It is found that an increase in arc-chamber temperature leads to a drop in the total pressure at the jet axis. The electron concentration in the plasma is determined spectrographically from the absolute intensity of the continuum and from Stark broadening. The electron temperature is determined from the intensity of the Ar(I) lines. The electron concentration and temperature, at large distances from the nozzle exit, are determined with the aid of Langmuir probes. The axial and radial electron-temperature distributions are diagramed, together with the distribution of the excited atom concentration. The spectrographic and probe measurements show that the electron temperature decreases abruptly near the nozzle exit, remaining practically constant at large distances from the nozzle. The electron concentration along the jet axis is found to vary in the same manner as the electron temperature, and to substantially exceed its equilibrium value. The radial electron concentration and temperature distributions, at large distances from the nozzle, are found to correlate well with the general gas-dynamic flow pattern. The observed decrease in total pressure, with increasing arc-chamber pressure, is attributed to the decrease in Mach number at the nozzle exit, and to the decrease in specific-heat ratio with increasing ionization of the argon gas. Spectrograms of two cross sections of the jet are included. (ATD)

33377 DOUBLE SPHERICAL ELECTROSTATIC PROBE CONTINUUM THEORY AND ELECTRON TEMPERATURE MEASUREMENT. Bradley, D.; Matthews, K. J. (Univ. of Leeds, Eng.). Phys. Fluids, 10: 1336-41(June 1967).

The continuum theory and numerical solutions of Su and Lam for single spherical probes are used to derive double-probe current–voltage characteristics. These characteristics are used to test the validity of the expression for electron temperature derived by Johnson and Malter on the basis of collisionless theory. It is found that the expression gives reasonably accurate values of electron temperature for continuum conditions. Values of correction factor are presented to enable more accurate electron temperatures to be derived from the expression of Johnson and Malter. (auth)

33378 MEASUREMENT OF THE ANISOTROPIC ENERGY DISTRIBUTION OF ELECTRONS IN AN ELECTRON CYCLOTRON RESONANCE PLASMA. Shohet, J. L.; Gitomer, S. J. (Univ. of Wisconsin, Madison). Phys. Fluids, 10: 1359-60(June 1967).

The anisotropy of the electrons in an electron cyclotron resonance plasma has been measured by means of the plasma diamagnetism and particle end flux out of a uniform magnetic field region. Measurements of x rays produced by the plasma were also made. (auth)

33379 ARC MEASUREMENT OF HIGH-TEMPERATURE GAS TRANSPORT PROPERTIES. Emmons, Howard W. (Harvard Univ., Cambridge, Mass.). Phys. Fluids, 10: 1125-36(June 1967).

A confined electric arc for the determination of gas transport

properties is developed to the point that the resultant properties are found within a few percent. The measurements include the arc electrical gradient characteristic, the flow pressure drop, the radiative heat transfer, the spectral temperature distribution, and microwave resonance characteristics. Values of the electrical and thermal conductivity of equilibrium argon are tabulated for the temperature range from 7,500 to 13,750°K. Helium in the confined arc at atmospheric pressure up to 400 A is shown not to be in thermodynamic equilibrium and hence its equilibrium properties cannot be determined by use of this experimental arrangement. (auth)

33380 STRUCTURE OF WIND-DRIVEN PLASMA TURBULENCE AS RESOLVED BY CONTINUUM ION PROBES. Granatstein, V. L. (Bell Telephone Labs., Inc., Whippany, N. J.). Phys. Fluids, 10: 1236-44(June 1967).

Argon gas is forced through a discharge tube to set up subsonic turbulent pipe flow. The resulting fluctuations in plasma density (excited by the "mixing-in-gradient") are investigated with continuum ion probes; the limits within which such probes can be used for fluctuation measurements are delineated. The flow is frozen and the small-scale structure of the plasma turbulence is homogeneous. For Reynolds number greater than 6000, the rms value of plasma density fluctuation approaches 100% of the mean plasma density, the fluctuation intensity is essentially constant along the tube axis, and a nascent inertial subrange ($K^{-5/3}$) appears in the plasma spectrum. The electrons are not in thermal equilibrium with the gas, and differences between the plasma and neutral spectra result. (auth)

33381 ION RESONANCE PROBE FOR THE MEASUREMENT OF PLASMA DENSITIES. Kiyama, Satoru; Kato, Kiyoe (Electrotechnical Lab., Tokyo). Jap. J. Appl. Phys., 6: 1002-4(Aug. 1967).

A new resonance probe method for the measurement of plasma densities is described. The principle of this method lies in the fact that in a uniform plasma the ion resonance can be observed near the ion plasma frequency f_{pi}, if the probe is biased sufficiently negative with respect to the space potential of the plasma. As the effect of the ion resonance on the rectified current out of the probe was very small, a direct-display method using a frequency swept signal generator was adopted. The density obtained by this method was compared with the one measured by a usual Langmuir probe. A good agreement was obtained between the two. (auth)

33382 STARK EFFECT IN PLASMA. Grabowski, Boleslaw. Postepy Astron., 15: 63-96(June 1967). (In Polish).

The process of pressure broadening of the spectral lines in plasma, viz. the Stark effect, is considered. The historical development of the problem and a review of the more important modern achievements of the theory of the Stark effect in plasma, particularly those of astrophysical interest, are given. Applications of the theory to such problems as line profiles, equivalent widths, and asymmetry of lines are discussed. (auth)

33383 TWO-CHANNEL FABRY–PEROT INTERFEROMETER FOR THE MEASUREMENT OF DOPPLER TEMPERATURES. Platz, Peter (EURATOM-CEA, Fontenay-aux-Roses, France). Appl. Opt., 6: 1205-8(July 1967).

The true width of a Doppler-broadened emission line may easily be determined by measuring the peak and wing intensities of the fringe pattern. The ratio of these intensities as a function of the half-width of the line and of various instrumental parameters is discussed. This method has been used to study the ion temperature of a pulsed plasma. (auth)

33384 EVALUATION OF CONDUCTIVITY OF LOW-TEMPERATURE (UF) PLASMA OF HIGH DENSITY. Kudrin, L. P. At. Energ. (USSR), 22: 265-71(Apr. 1967). (In Russian).

The electron and ion conductivity of plasma in the temperature range from 0.4 to 3 eV was evaluated for conditions of thermodynamic equilibrium. The evaluation showed that the determining role is played by non-Coulomb collision processes of electrons in the plasma. The electroconductivity can differ from the Spitzer conductivity by several orders of magnitude. (tr-auth)

33385 RELAXATION THEORY OF SPECTRAL LINE BROADENING IN PLASMAS. Smith, Earl William. Gainesville, Fla., Univ. of Florida, 1966. 194p.

Thesis.

A relaxation theory of spectral line broadening in plasmas is presented. This theory makes use of the Liouville operator formalism and projection operator techniques developed by Zwanzig. The relaxation theory for line broadening in plasmas is based on a theory of pressure broadening in neutral gases developed by Fano. (TSS) (Disser. Abstr.)

33386 IMPROVEMENTS IN AND RELATING TO METHODS OF MEASURING AND APPARATUS RESPONSIVE TO PLASMA DENSITY. (to Japan Atomic Energy Research Inst.). British Patent 1,076,675. July 19, 1967. Priority date June 5, 1964, Japan.

A method of measuring the density of a plasma and the apparatus for measuring or responding to changes in the density of the plasma are described. The invention is based on the fact that the impedance of a plasma is a function of the plasma electron density. (M.O.W.)

33387 CONDUCTIVITY OF A PARTIALLY IONIZED PLASMA IN THE LONG WAVELENGTH LIMIT. Joyce, Glenn Russell. Columbia, Mo., Univ. of Missouri, 1966. 100p.

Thesis.

The conductivity of a partially ionized, homogeneous plasma near equilibrium is calculated. Interactions between charged particles are treated by B.B.G.K.Y. methods and interactions between neutral and charged particles are treated by a Boltzmann collision integral. An integral equation for pair correlations between charged particles is set up and solved in terms of one-particle distribution functions. In the high-frequency limit, an explicit evaluation of the conductivity is obtained. Numerical calculations are made in the limit of infinite ion mass. The results are studied in terms of a charged particle–charged particle collision frequency. This effective collision frequency is found to depend on the neutral particle density and on the external field frequency. For field frequencies below the electron plasma frequency, the effective collision frequency is a constant which is in good agreement with the effective electron–ion collision frequency calculated from the Boltzmann equation. At the electron plasma frequency, the collision frequency begins to decrease and finally becomes constant again for frequencies much higher than the electron plasma frequency. (Disser. Abstr.)

33388 VISIBLE CONTINUUM IN AN ARGON POSITIVE COLUMN. Prince, John Franklin. Austin, Univ. of Texas, 1966. 144p.

Thesis.

The continuous radiation (3000 to 7000 Å) emitted from the positive column of a low-power-input, high-purity argon dc discharge was investigated. The functional dependence of this continuum on the discharge pressure and current was examined for pressures of 5 to 30 torr and currents of 0.5 to 8 mA. It was established that the continuum radiated from the argon positive column is not the result of ion–electron recombination and electron bremsstrahlung, commonly called free–bound and free–free transitions. A molecular model is proposed which predicts the functional dependence of the continuum on the discharge parameters and approximates the observed measured absolute intensity. This model indicates that the observed continuum is radiated during transitions between highly excited, bound argon molecular states and dissociative lower states. It is further proposed that the radiating molecular states are populated by electron excitation of metastable argon molecules which are formed in a three-body process by metastable argon atoms and two ground state atoms. (Disser. Abstr.)

33389 RADIATIVE BEHAVIOR OF SHOCK HEATED ARGON PLASMA FLOWS. Horn, Kenneth Porter. Stanford, Calif., Stanford Univ., 1966. 115p.

Thesis.

Experimental and theoretical studies were made of the decrease in the degree of ionization of shock heated argon resulting from radiative emission. Optical interferometry used in conjunction with a rotating-mirror camera provided a time history of the mass and electron densities following strong shocks. After a short electronic relaxation period the hot-highly luminous gas reached local thermodynamic equilibrium. Then, loss of energy by radiation led to cooling of the gas as evidenced by the decreasing electron density. On the assumption that the dense plasma (10^{17} electrons per cc) passed through successive equilibrium states upon cooling, the change in the temperature and in the number of density of the electrons could be related by use of the Saha equation. The change in degree of ionization thus determined was compared with calculated values, assuming continuum emission by free–free and free–bound transitions and emissions from spectral lines. Theory and experiment were in good agreement, for a realistic choice of the parameters contained in the continuum theory. The analysis indicated that line radiation losses could not be disregarded. Sizable loss resulted from lower level bound–bound transitions even though these lines experienced absorption. Various radiation absorption models were investigated. (Disser. Abstr.)

Kinetics of Plasma

Refer also to abstract 33558.

33390 (AD-631859) RESEARCH ON ELECTROMAGNETICS FOR PROJECT DEFENDER. Semiannual Technical Summary for March 31, 1966. Hutter, Rudolf G. E. (Polytechnic Inst. of Brooklyn, N. Y. [Microwave Research Inst.]). Contract Nonr-839(38). 298p. (PIBMRI-1295.2-66). CFSTI.

Progress on a fairly large number of projects is described in this semiannual report. With one exception, these projects can be grouped into four categories: plasma, electromagnetics, fluid dynamics and ablation studies. The general theme of nearly all projects in the first three groups is the concern with the electromagnetic properties of ionized gases and/or plasmas, such as the properties of antennas, excitation of waves in plasmas, propagation through plasmas, measurement of electron densities of shock waves, precursor studies of shocks, instabilities in plasmas, properties of laboratory plasmas. One contribution is concerned with the basic kinetic theory of ionized media. A few others are concerned with gas flow problems. The work on ablation was just incorporated in the program, and one contribution deals with this subject. (auth)

33391 (AD-640237) COUPLED WAVES IN MAGNETO-IONIC MEDIA. PART I. Rydbeck, O. E. H.; Hjalmarson, A. (Rydbeck Research Associates, Fjaras (Sweden)). June 1966. Contract AF61(052)-864. 124p. (AFCRL-66-651(Pt.1)). CFSTI.

Coupled magneto-ionic equations in total fields, for arbitrary primary wave incidence and arbitrarily varying medium parameters, are solved in terms of first order mode amplitude equations, expressed in terms of so called "inhomogeneous" or "homogeneous" wave numbers. For media with symmetric wave propagation properties, the first order mode amplitude equations can also be replaced by gradient coupled, second order wave equations in so called characteristic components. The gradient coupling terms can then be separated in vertical incidence, and oblique incidence components. Expressions are derived for the mode transfer reflection coefficients, and mode transmission coefficients for an arbitrary, stratified magneto-ionic medium. Several propagation cases, also with characteristic mode or z-component coupling, are discussed. (auth) (TAB)

33392 (AD-641661) RADIATION CONDITION FOR A MAGNETOPLASMA MEDIUM. [PART] I. Seshadri, S. R.; Wu, T. T. (Sylvania Electronic Systems, Waltham, Mass. Applied Research Lab.). Nov. 1966. Contract Nonr-3185(00). 51p. (RR-502). CFSTI.

The radiation condition is discussed for an unbounded magnetoplasma which is both anisotropic and dispersive. The usual form of the celebrated Sommerfeld radiation condition pertains to an isotropic and nondispersive medium and is not applicable to a magnetoplasma. A technique based on the principle of causality for the resolution of the consequent ambiguity is discussed. The branch points and the associated branch cuts of the integrands in the Fourier integral representations of the two modes which compose the actual field component in a steady-state problem are examined with particular emphasis on certain of the branch points which have been overlooked in the existing literature. (auth)

33393 (AD-642271) RESEARCH ON ELECTROMAGNETICS FOR PROJECT DEFENDER. Semiannual Technical Summary Report. Hutter, Rudolf G. E. (Polytechnic Inst. of Brooklyn, N. Y. Microwave Research Inst.). Sept. 30, 1966. Contract Nonr-839(38). 285p. (PIBMRI-1295.3-66). CFSTI.

Progress on a fairly large number of projects is described in this semiannual report. With one exception, these projects can be grouped into four categories: plasmas, electromagnetics, fluid dynamics, and ablation studies. The general theme of nearly all projects in the first three groups is concerned with the electromagnetic properties of ionized gases and/or plasmas, such as the properties of antennas, excitation of waves in plasmas, propagation through plasmas, measurement of electron densities of shock waves, precursor studies of shocks, instabilities in plasmas, properties of laboratory plasmas and basic kinetic theory of ionized media. A few others are concerned with gas flow problems. The contribution on ablation is the final one on this contract. (auth) (TAB)

33394 (AECL-2669) TEST PARTICLES IN AN ARGON PLASMA. Ormrod, John H. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan. 1967. 38p. Dep. CFSTI. AECL $1.00.

The energy loss of fast photons and deuterons traversing an argon hollow cathode discharge has been measured for proton energies of 10 to 70 keV. The plasma electron temperature was $\sim 6 \times 10^4$ °K and the number density $\sim 10^{14}$ cm^{-3}. The measured rate of energy loss was much less than the theoretical value. Experimental effects that might explain this discrepancy have been investigated; it is concluded the theory overestimates the rate of energy loss by a factor of two or three. (auth)

33395 (AFWL-TR-66-121) STUDIES AND EXPERIMENTAL WORK ON ATOMIC COLLISION PROCESSES OCCURRING IN ATMOSPHERIC GASES. Technical Report, December 22, 1965-September 1, 1966. Phelps, A. V.; Kasner, W. H. (Westinghouse Research Labs., Pittsburgh, Pa.). May 24, 1967. Contract AF 29(601)-6729. 56p.

Microwave and mass spectrometric techniques have been used to study electron-ion recombination in the afterglow of "single-pulse" microwave discharges under conditions where 0_4^+ is the only significant afterglow ion species. At room temperature (~300°K) the measured recombination coefficient, $\alpha(0_4^+)$, has a value of $(2.2 \pm 0.4) \times 10^{-7}$ cm^3/sec. A significant temperature dependence for $\alpha(0_4^+)$ has been observed, the values ranging from approximately 3.6×10^{-7} cm^3/sec at 200°K to 1.8×10^{-7} cm^3/sec at 550°K. Several associative detachment reactions involving the negative ion 0^- have been studied. The measured reaction rates are all in excess of 10^{-10} cm^3/sec. In particular, a preliminary value of 4×10^{-10} cm^3/sec has been obtained for the $0^- + 0$ associative detachment reaction. The apparent destruction of 0_2^- by 0 has also been observed, but no reliable quantitative results are available at this time. The energy dependence of some of these reactions have been studied over the range 0.042 to 0.10 eV. (auth)

33396 (CONF-670104-Pt.1, pp 67-77) EFFECTS RELATED TO THE RADIAL ELECTRIC FIELD IN A Q-MACHINE. Grieger, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)).

In a Q machine with end plates heated to a uniform temperature there must exist a radial electric field proportional to the gradient of the mean particle density. This is a consequence of the necessarily existing radially directed macroscopic motions within the plasma and leads to a deviation from the thermal equilibrium. This electric field influences the velocity distribution of the ions and yields an upper limit for the steepness of the density profile. For a certain range of particle densities, the ion loss rates are also somewhat increased. (auth)

33397 (CONF-670104-Pt.1, pp 35-47) SINGLE-ENDED OPERATION OF A Q-DEVICE. Guilino, E.; Hashmi, M. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)).

The double-ended operation of a Q-device in the collision-dominated case is adequately described by the "equilibrium theory." However, single-ended operation becomes important for a number of experiments. As a state of perturbed equilibrium, single-ended operation should reveal properties deviating from double-ended operation. The ion density in ALMA III is measured by Langmuir single probes in single-ended operation and compared with the corresponding double-ended density. This is done for various sheath conditions (end-plate temperature, density) and potentials of the cold end plate. It turns out that essential characteristics of plasma in single-ended operation are described by a "modified equilibrium theory." (auth)

33398 (CONF-670104-Pt.1, pp 79-87) EFFECTS RELATED TO ION COOLING IN A Q-DEVICE. Blau, F. P.; Guilino, E.; Hashmi, M. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)); D'Angelo, N. (Danish Atomic Energy Commission, Risoe, Research Establishment).

It is known that the typical operating conditions of a Q device can be significantly changed if the degree of ionization and the ion temperature are reduced. This is achieved by the introduction of a noble gas into the plasma column at room temperature, which causes, among other effects, an increase in sheath potential and plasma density. In addition, low-frequency oscillations are excited. The behavior of the plasma as a function of neutral gas pressure is investigated for different gases, plate temperature, densities and magnetic fields. (auth)

33399 (CONF-670104-Pt.1, pp 95-105) STATIC POTENTIAL DISTRIBUTIONS IN THE SINGLE EMITTER DIODE. Ott, W. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)).

The electric field distribution in a diode was measured using a ribbon electron beam. The corresponding potential distribution agrees within 10 and 20% with collisionless theory. (auth)

33400 (CONF-670104-Pt.1, pp 111-18) EFFECT OF ION-ION COLLISIONS AND SHEAR ON RESISTIVE DRIFT MODES. Laval, G.; Pellat, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires).

The dispersion relation obtained by Coppi and Rosenbluth which takes electron-ion and ion-ion collisions into account using a BGK collision operator and including microscopic effect was used. The stabilizing influence of ion-ion collisions on the resistive drift mode for high collision rates was studied. Stability criterions were found for normal modes and convective perturbations. (auth)

33401 (CONF-670104-Pt.1, pp 119-28) LOW-FREQUENCY OSCILLATIONS IN A PLASMA WITH NEGATIVE IONS. Popovic,

M.; Melchior, Henning (Danish Atomic Energy Commission, Risoe. Research Establishment. Tekniske Hoejskole, Copenhagen (Denmark)).

A dispersion relation for low-frequency waves in an inhomogeneous plasma with negative ions has been derived in the three-fluid approximation. The plasma has a strong magnetic field along the z axis and a density gradient along the x axis. Solutions for waves propagating in the yz plane have been computed. New modes are found, some of which are excited even in the absence of collisions. (auth)

33402 (CONF-670104-Pt.1, pp 173-80) DRIFT WAVES IN A CESIUM PLASMA. Little, P. F.; Barrett, P. J. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.).

Measurements were made on a small cesium plasma to determine the steady state parameters and the characteristics of the low-frequency oscillations present. It is shown that the experimental spectrum of oscillations can be accounted for theoretically if the effects of large Larmor radii and significant radial electric fields are included. (M.O.W.)

33403 (IAE-1176) ZHELOBKOVYE KOLEBANIYA RAZREZHENNOI PLAZMY S NEKOMPENSKIROVANNYM PROSTPANSTVENNYM ZARYADOM. II. (Flute Oscillations of Rarified Plasma With Noncompensated Space Charge. II.). Timofeev, A. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1966. 20p. (In Russian). Dep.

It was shown (Zh. Tekh. Fiz., 36: No. 10, (1966)) that plasma eigenoscillations may be absent if the radial electric field varies linearly with distance. Starting from the basic oscillation of plasma flute oscillations the author shows that singular turning points exist and that eigenoscillations may again be absent at a sufficiently high value of space charge and a monotonic distribution of the electric field. Consequently, the absence of eigenoscillations characterizes slipping system plasmas, and this stabilizes the plasma. The result is obtained by the quasi-classical approximation and is thus applicable to small-scale oscillations localized in the interior of the plasma. (JPRS)

33404 (NASA-CR-819) SEARCH FOR PLASMA OSCILLATIONS STIMULATED BY A PRE-BUNCHED ELECTRON BEAM FROM THE RENSSELAER LINEAR ACCELERATOR. Mendell, J. S.; Holt, E. H. (Rensselaer Polytechnic Inst., Troy, N. Y.). July 1967. 55p. CFSTI.

An experiment is described in which the electron beam from the R. P. I. Linear Accelerator was passed through an argon plasma to discover whether microwave oscillations could be detected outside the discharge vessel. As an experiment in plasma oscillations it is unique in the high energy of the beam and its pre-bunched nature. Because of resonance between the plasma frequency near the axis of the vessel and the sixteenth harmonic of the beam's fundamental frequency, the plasma electrons are expected to gain energy from the beam. The energy stored in the beam–plasma interaction region is expected to be high relative to the energy that the field of the beam would produce in free space. Some of this energy is expected to escape from the vessel in the form of microwave radiation. A special microwave bridge and receiver were constructed for the study of the radiation. According to a harmonic analysis of the Linac beam current, based upon an examination of the energy spectrum of the Linac, a peak beam current of 0.3 A contains a sixteenth harmonic component of about 0.1 A amplitude, whose frequency is the same order of magnitude as the plasma frequency, but this beam current passing through the discharge did not stimulate oscillations that could be detected with a K-band receiver placed outside the vessel. Taking into account the vessel–antenna geometry and the receiver sensitivity, it is concluded that any radiation produced by the beam was at a level lower than 0.4×10^{-10} watts per centimeter of plasma traversed. (auth)

33405 (NASA-TN-D-4058) ION CYCLOTRON WAVE GENERATION IN UNIFORM AND NONUNIFORM PLASMA INCLUDING ELECTRON INERTIA EFFECTS. Sigman, Donald R.; Reinmann, John J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). July 1967. 47p.

Theoretical calculations were made for radiofrequency power transfer to ion cyclotron waves from a Stix coil. The analysis includes electron inertia terms and is applied to a cylindrical column of cold, collisionless atomic-hydrogen plasma with and without radial density variations. The results showed both an optimum coil wavelength and an optimum density for efficient power transfer. For typical plasmas, the optimum density is between 1×10^{12} and 5×10^{12} cm^3. Without a radial density gradient, the inclusion of the electron inertia terms reduced the predicted power transfer. Several radial density distributions were considered. Power transfer to inhomogeneous plasmas is maximum when the volume average density is near the optimum density computed for homogeneous plasmas. Curves of power absorption as a function of magnetic field for inhomogeneous plasmas were similar to those for constant density. Under some conditions, radiofrequency power is coupled predominantly to a single plasma mode of oscillation; under other conditions, the power may be distributed among several modes. Thus, measurements of plasma wave properties may prove difficult to interpret. (auth)

33406 (NP-16829) TRANSFORMATSIYA VOLN V SREDE SO SLUCHAINYMI NEODNORODNOSTYAMI. (Wave Transformations in Media With Random Inhomogeneities). Preprint 44. Zaslavskii, G. M.; Filonenko, N. N. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1966. 14p. (In Russian). Dep.

In weakly inhomogeneous media, wave transformations may occur because of presence of resonance regions. While crossing such regions, the amplitudes of quasi-normal oscillatory modes change discontinuously and a redistribution of energy appears over these quasi-normal modes. The authors investigated the statistical approach to wave transformation (as defined above) within a medium with a large number of randomly distributed transformation regions. The kinetic equation for the oscillation amplitude distribution has been derived and the equilibrium solution shows equal average values of actions from each oscillation mode. Characteristic relaxation lengths have been determined and the possibility of anomalously large transformations independent of the initial conditions has been established. The method is applicable to an arbitrary number of coupled oscillations. (JPRS)

33407 (R-67SD28) BLOWING OF CURRENT PATTERNS IN NON-EQUILIBRIUM PLASMAS. Sherman, Arthur; Yeh, Hsuan (General Electric Co., Philadelphia, Pa. Missile and Space Div.). May 1967. Contract AF 49(638)-1609. 8p.

Calculations were made of the displacement of current patterns in nonequilibrium plasmas due to a flow. Convection of energy is considered via the electron energy equation, but finite ionization rates are neglected. A pair of point electrodes in a parallel walled channel is chosen as a convenient problem to illustrate the solution procedure. It is found that the electron temperature distribution becomes skewed, the current displaced downstream, and the voltage to pass a given current is increased as the flow velocity becomes higher. (auth)

33408 (RAE-TN-AERO-2742) A NOTE ON A POSSIBLE EXPERIMENT ON THE PROPAGATION OF LONGITUDINAL WAVES THROUGH AN IONISED GAS IN THE PRESENCE OF A MAGNETIC FIELD. Broadbent, E. G. (Royal Aircraft Establishment, Farnborough (England)). Mar. 1961. 19p. Dep. CFSTI.

Consideration is given to the production of an ionized gas in conditions suitable for experiments on the propagation through it of sound waves at wave lengths below the mean free path. The conditions suggested to give about the same degree of ionization as exist in the ionosphere are either cesium vapour at 1650°K or potassium vapour at 1800°K in a chamber of about 20 cm length and 10 cm diameter. An axial magnetic field that could be varied up to 5000 gauss would be desirable to check the directional effect of the waves at frequencies below the ion gyro frequency in a low beta plasma. Experimental techniques and chamber material are not discussed in any detail. The vapour pressure is somewhat less than 10^{-4} atmospheres. (auth) (UK)

33409 (UCRL-17178) ELECTRICAL BREAKDOWN OF HYDROGEN ACROSS A STRONG MAGNETIC FIELD IN COAXIAL GEOMETRY. Sherwood, Arthur Robert (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 28, 1967. Contract W-7405-eng-48. 97p. Dep. CFSTI.

Thesis.

The formative time of electric breakdown in low-pressure (0.2 to 2.0 torr) hydrogen across a strong magnetic field ($10 < \omega_b\tau < 350$; maximum B of 18 kG) has been measured in a coaxial cylindrical geometry. Attention was centered on that region of breakdown that occurs with a formative time less than the time required for an electron to drift across the electrode gap in the applied fields. This crossing time was inferred by extrapolations of previous measurements by Bernstein. These formative time measurements are compared with a simplified theory which assumes a constant number of e-folding times until breakdown and neglects electron losses as well as secondary production at the cathode. This model predicts that the formative time is inversely proportional to the gas pressure and otherwise a function of only the ratio E/B and not of either field separately. The predicted pressure dependence is confirmed, but deviations from the predicted functional dependence on E/B are found. These deviations are attributed to electron losses along the magnetic field. Reasonable agreement with the predicted magnitude of the formative time is obtained. (auth)

33410 (NP-tr-1536) FAST-ACTING STRIP ELECTRODYNAMIC VALVE FOR PERIPHERAL GAS ADMISSION. Filippov, N. V.; Golubchikov, L. G.; Ivanov, V. D. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translation of report IAE-1116. 15p. (CTO-375). Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The characteristics of an electrodynamic valve suitable for rapidly producing a fairly large annular gas blob are investigated experimentally and theoretically. Considerable homogeneity and symmetry of this blob can be obtained. The valve-open time can be adjusted between 20 and 70 μsec during which up to 1 cm^3 of air at atmospheric pressure can be admitted. Methods for improving the valve operating speed are discussed. (auth)

33411 NONLINEAR INTERACTION OF HELICONS (WHISTLERS) IN INHOMOGENEOUS MEDIA. Sudan, R. N. (Cornell Univ., Ithaca, N. Y.); Cavaliere, A.; Rosenbluth, M. N. Phys. Rev., 158: 387-96(June 10, 1967).

The nonlinear interaction of helicons (whistlers) is found to depend radically on whether the plasma has diffuse or sharp boundaries. The conventional picture of three-wave interaction obtained by perturbing the normal-mode amplitudes is valid for the diffuse case. However, for a plasma with sharp boundaries, e.g., a solid-state plasma including collisions, surface currents play an important role in the limit of large $\Omega\tau$, where Ω is the electron gyrofrequency and τ is the relaxation time. It is shown that the normal-mode method breaks down even at very small amplitudes. A new strong-coupling method is developed which predicts an interaction rate in the large-$\Omega\tau$ limit that never exceeds the order of the wave linear damping, but should be experimentally observable. (auth)

33412 DETERMINATION OF CURRENT FLOW IN PLASMA BY USE OF MODELS. Bortnichuk, N. I. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 141-3(Jan.-Feb. 1967). (In Russian).

A method for the determination of the density distribution of the current flowing in the plasma between two electrodes is presented. This method accounts for anisotropic conductivity due to plane-parallel and radially-symmetric electric and magnetic fields. This method transforms the generalized Ohm's equation into new coordinates and shows that under some weak restrictions the resulting form is that of the Laplace equation. Therefore, the problem can be solved using models for which the boundary conditions remain unchanged. However, the boundary which limits the flow is changed and a description of this boundary is given. The results of such use of models are shown graphically. (ATD)

33413 APPROXIMATE SOLUTION OF THE STATIONARY HIGH-FREQUENCY INDUCTION DISCHARGE IN A CLOSED VOLUME. Gruzdev, V. A.; Rovinskii, R. E.; Sobolev, A. P. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 143-50(Jan.-Feb. 1967). (In Russian).

A theoretical description of temperature, current and energy distributions in dense plasma discharges is given. It is assumed that the departure from the equilibrium temperature is small and that the dominant energy transfer mechanism is thermal conduction. Since it is assumed that local thermodynamic equilibrium exists, all transfer coefficients are functions of temperature and pressure only, reducing the problem to that of energy balance consistent with Maxwell's equations. The method of iterative approximations is used to obtain the solutions. These are determined for specific examples which are used for comparison with the experimental results of other authors. Comparison between computed and experimental results are shown graphically. The disagreements that are evident are ascribed to the experimental interpretations of the data and poorly defined boundary conditions. In addition, the study criticizes a similar study by Soshnikov and Trekhov and enumerates its deficiencies. (ATD)

33414 CARRIER GAS FLOW IN AN OUTPUT STREAM OF AN ELECTROMAGNETIC ACCELERATOR. Bam-Zelikovich, G. M. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 8-13(Jan.-Feb. 1967). (In Russian).

In analyzing the motion of carrier gas after exiting from an electromagnetic accelerator into a vacuum, all flow parameters are studied on the assumption that the stream is level, that there are no Hall currents, and that speed increments are small in comparison with stream velocity. On the basis of a rectangular channel, wide enough to form a level stream at high velocities of 5×10^6 to 10^7 cm/sec, a series of four formulas is given, including gas density, axial velocities, magnetic field tension, constant gas conductivity, and the speed of light. Limiting conditions for these equations are discussed in relation to the distortion of electric lines at the end of the channel. A sharp drop in gas conductivity at a distance from the channel exit permits the assumption that no current is transmitted in certain sections of a long stream. Formulas are developed for linearizing gas motion and induction, for gas density, distribution of magnetic tension, and for projected gas flow rates between the stream core and boundary layer. The distribution of increments in projected velocity, the relation of gas compression to flow rate, and coordinates for other values are plotted graphically. (ATD)

33415 EXCITATION OF PLASMA OSCILLATIONS BY PARAMETRIC RESONANCE. Okutani, Jun-ichi (Tokyo Univ.). J. Phys. Soc. Jap., 23: 110-13(July 1967).

A typical example of parametric resonance of plasma oscillations is theoretically investigated. When the width of a plasma slab is periodically perturbed with frequency $(2 + \epsilon)\Omega$, the plasma oscillation is exponentially enhanced with time, where $\Omega = \{1 + (3/2)(n\pi a/l_0)^2\}\omega_0$ is the characteristic frequency of the plasma slab, ω_0 being the plasma frequency, a the Debye length, l_0 the width of the slab, n an integer, and $|\epsilon| \ll 1$. The growth rate γ_R is given by $\gamma_R{}^2 = (1/4)(\sigma^2 - \epsilon^2)\omega_0^2$, where $\sigma = (n\pi a/l_0)^2$ h, h being the ratio of change of width to l_0. In a magnetic field the Bernstein mode is also excited by parametric resonance. (auth)

33416 VELOCITY LIMITATION WHEN ACCELERATING PLASMA. Jelen, J. (Czech Technical Univ., Podebrady). Czech. J. Phys., 17: 475-8(1967).

The velocities of plasma accelerated in plasma guns or shock tubes are investigated and compared with the values predicted by theoretical computations, based on simplifying conceptions. Explanations for the disagreements between experiment and theory are offered in terms of the equation of motion of an accelerated plasma. (M.O.W.)

33417 INVESTIGATION OF THE CYLINDRICAL WAVES IN RAREFIED PLASMA. Berezin, Yu. A.; Kurtmullaev, R. Kh. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 116-24(Jan.-Feb. 1967). (In Russian).

The propagation of strong cylindrical waves in cold plasma is studied theoretically and the results are compared with an experiment. The propagation of the wave is considered for regimes where dissipative effects are sufficiently strong, so that nonlinear effects arise over distances much smaller than that of the radius of plasma under study. The current sheet driving the magnetic perturbance is described as exponential or sinusoidal in time. The experimental results on the properties of the wave were obtained by means of magnetic probes at various radii in the plasma column. The comparison of the experimental results with the computer output is limited since the latter assumes a constant dissipation factor. However, the qualitative agreement is good and a predicted case of the minimum wave-front thickness is observed when the growth rate of waves becomes small due to reduced initial plasma density. (ATD)

33418 DAMPING OF PLASMA OSCILLATIONS IN A MAGNETIC FIELD. Mazitov, R. K.; Fridman, A. M. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 134-5(Jan.-Feb. 1967). (In Russian).

A study of the influence of a weak magnetic field on the conditions for the damping of the electron plasma oscillations is reported. Using a quasi-linear approximation, it is shown that the solution to the distribution function equation lacks the plateau region which is a requirement for the growth of electron oscillations. The damping constant for a plasma with weak magnetic field is derived by suitable simplifications of the distribution function equation and subsequent averaging. This constant differs from that for a nonmagnetic plasma by a factor proportional to the electron cyclotron frequency and inversely proportional to the initial spectral density of the electric field of the wave. (ATD)

33419 INVESTIGATION OF LANDAU-DAMPING EFFECTS ON SHOCK FORMATION. Andersen, H. K.; D'Angelo, N.; Michelsen, P.; Nielsen, P. (Atomic Energy Commission, Risoe, Denmark). Phys. Rev. Lett., 19: 149-51(July 24, 1967).

Landau damping in plasmas of equal ion and electron temperatures (alkali plasmas) may prevent the formation of a shock. Shocks are produced when the ratio T_e/T_i is increased to about 8 or so by cooling the ions through i-n collisions. (auth)

33420 STIMULATED EMISSION FROM THE UPPER-HYBRID RESONANCE IN A MAGNETOPLASMA. Hill, R. M.; Kaplan, D. E.; Ichiki, S. K. (Lockheed Palo Alto Research Lab., Calif.). Phys. Rev. Lett., 19: 154-6(July 24, 1967).

A new means for study of collective phenomena in the neighborhood of the upper-hybrid resonance is given. The technique used may also be adapted for determination of electron-density conditions in certain cases. (M.O.W.)

33421 RADIATION FROM A NONEQUILIBRIUM PLASMA. Dubovoi, A. P. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Zh. Eksp. Teor. Fiz., 52: 1736-44(June 1967). (In Russian).

The intensity and energy density of the radiation emitted into vacuum by a semi-infinite electron plasma with a non-Maxwellian

particle distribution are calculated on the basis of general fluctuation theory under the assumption of specular reflection of the electrons at the interface. (auth)

33422 COLLISIONLESS ELECTROSTATIC SHOCKS. Colgate, Stirling A. (New Mexico Inst. of Mining and Tech., Socorro); Hartman, Charles W. Phys. Fluids, 10: 1288-97(June 1967). (UCRL-70249).

A one-dimensional computational model of counter-streaming plasmas exhibits enhanced dynamic friction created by electrostatic instabilities. Buneman and Dawson previously demonstrated the validity of the sheet charge model, and using this model, the collective electrostatic interactions of two contra-streaming plasmas were calculated for mass ratios $m_i/m_e = 1$, 10, and 100. For initially cold plasma streams $KT_e = 7.5 \times 10^{-3}$ ($\frac{1}{2}m_e v_0^2$), $KT_i = 2.78 \times 10^{-3}$ ($\frac{1}{2}m_i v_0^2$) where v_0 is the stream velocity), electron oscillations grow to saturation in several electron plasma periods, creating a thermal electron distribution. Ion–electron oscillations then grow to saturation in several ion plasma periods ($1/f_{pi}$) with mean potentials of approximately $(\frac{1}{2}3m_i v_0^2)(m_e/m_i)^{\frac{1}{3}}$. These oscillations heat the electrons and thermalize the two ion streams in a time $13\,(m_i/m_e)^{\frac{1}{3}}/f_{pi}$. Two nonlinear effects occur (adiabatic electron modulation heating and electron trapping) that maintain the ion–electron instability. A larger mass ratio problem was not calculated because of computational time limitations, but an extrapolation of these results predicts the existence of electrostatic shocks for $m_i/m_e = 1836$. (auth)

33423 ONE-DIMENSIONAL MODEL OF A LORENTZ PLASMA. Shanny, Ramy; Dawson, John M.; Greene, John M. (Princeton Univ., N. J.). Phys. Fluids, 10: 1281-7(June 1967). (MATT-511).

A one-dimensional electron plasma model, in which electron sheets can scatter in three dimensions in velocity space through small-angle collisions with the stationary ions, has been constructed. Using the model, the dc conductivity of a Lorentz plasma is measured. The result agrees with the theoretical prediction, therefore confirming the validity of the model and exhibiting its capability for determining other transport coefficients. The decay rate of a standing wave when collisions are present is measured. The result verifies the theoretical result, in which the various decay increments are superimposed. The wavelength dependence of the collisional damping is observed. (auth)

33424 NUMERICAL STUDIES OF THE NONLINEAR VLASOV EQUATION. Armstrong, Thomas P. (Univ. of Iowa, Iowa City). Phys. Fluids, 10: 1269-80(June 1967).

The nonlinear one-dimensional Vlasov equation is solved numerically as an initial-value problem. The problem is the same as that considered by Knorr, and is related to, but not the same as, various one-dimensional model calculations using charged sheets. The electron distribution is doubly expanded, the spatial part being expanded as a Fourier series and the velocity part as a Gram–Charlier series. In this representation, the Vlasov equation appears as a matrix ordinary differential equation for the expansion coefficients and is first order in the time. Problems considered are nonlinear Landau damping and the development of strongly unstable initial conditions (two-stream instability). In the latter situation, the limiting amplitudes are computed. (auth)

33425 COUPLING OF LONGITUDINAL AND TRANSVERSE MODES IN A VLASOV PLASMA. Dolinsky, A.; Goldman, R. (Univ. of Maryland, College Park). Phys. Fluids, 10: 1251-61 (June 1967).

Equations are obtained for the time and space development of a small number of transverse and longitudinal modes in a Vlasov plasma. The scale times and lengths are inversely proportional to the first power of the electric fields. For the special case of two transverse waves and a single resonantly driven longitudinal oscillation, frequency conversion and polarization rotation effects appear. Qualitative differences are found between the behavior in one and two independent coordinates. In most (but not all) cases treated, the mode interactions cause changes in the electric field amplitudes rather than shifts in resonant frequencies and wavenumbers. (auth)

33426 BREMSSTRAHLUNG OF SLOW ELECTRONS IN NEUTRAL GASES AND FREE–FREE ABSORPTION OF MICROWAVES. Akcasu, A. Z.; Wald, L. H. (Univ. of Michigan, Ann Arbor). Phys. Fluids, 10: 1327-35(June 1967).

Bremsstrahlung of nonrelativistic electrons in a neutral gas is investigated including the polarization and exchange effects. The intensity and spectrum of the bremsstrahlung and of the induced dipole radiation are obtained for a Maxwellian distribution of electron energy in terms of the elastic scattering cross section of the atom for electrons and its polarizability. The interference of the induced dipole radiation with the bremsstrahlung is also considered. It is found that the exchange effects and the induced dipole radiation are negligible as far as the total radiated power is concerned. The latter, however, may be important at the short-wave end of the spectrum. Finally, the absorption coefficient is obtained from the bremsstrahlung cross section. The results are evaluated explicitly for a Maxwellian distribution. (auth)

33427 EXPERIMENTAL STUDY OF RUNAWAY ELECTRONS IN A PLASMA BETATRON. Ferrari, L. A.; Rogers, K. C. (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Fluids, 10: 1319-26(June 1967).

Runaway electrons generated by induction acceleration in a plasma betatron with axially symmetric guide field $B_z(r, z, t) = B_0(r_0/r)^n f(z) \sin 2\pi t/T$; ($n = 0.43$, $T = 16\mu$sec, $r_0 = 4.8$ cm) together with auxiliary azimuthal guide field $B_\theta(r) = \text{const}/r$; ($2\text{ kG} \leq B_\theta(r_0) \leq 5\text{ kG}$) have been studied for a wide range of induction electric fields E_θ; $2.5\text{ V/cm} \leq E_\theta(r_0) \leq 26\text{ V/cm}$). Experiments have been carried out in argon and krypton at ambient pressure of $(0.5–2) \times 10^{-3}$ torr. Runaway currents of ≈ 1 A were observed as immersed in a background conduction current of 25–100 A. After a period of normal-betatron-acceleration-beam disruption occurs, and the energetic runaways strike the vacuum-chamber walls. The beam-disruption time t_x has been measured as a function of E_θ and B_θ for several half-cycles of the betatron guide field. A space-charge theory is developed in order to explain the small runaway currents. Reasonably good agreement with the experimental results is obtained over a wide range of parameters. The reason for the beam disruption of subsequent x-ray emission is unexplained. (auth)

33428 WAVES IN COLLISIONLESS PLASMAS. II. LONGITUDINAL WAVES. Levin, Joel M. (General Electric Co., King of Prussia, Pa.). Phys. Fluids, 10: 1307-18(June 1967).

The problem of longitudinal waves in an infinite one-dimensional plasma is treated by expressing the charge density in terms of the exact solution of the collisionless Boltzmann equation and then solving Poisson's equation. For an initially homogeneous plasma the electric field is determined exactly. For an initially inhomogeneous plasma an iterative procedure is developed which in principle determines the electric field for an arbitrary initial inhomogeneity. If the initial inhomogeneity is small with respect to the homogeneous part of the distribution function the problem can be treated by perturbation theory. To each order the field is found to obey a linear integral equation which is readily solved in terms of a Green's function, $\Gamma(z,t)$, which maps the known nth-order source function into the nth-order field. For $t \neq 0$, the Fourier transform of $\Gamma(z,t)$ is a sum of damped oscillations whose complex frequencies are determined for all $0 < t < \infty$ by the plasma-dispersion relation. A general procedure for solving this dispersion relation is developed. For a Maxwellian plasma an infinite number of frequencies are determined for large k in addition to the usual Landau results for small k. A physical interpretation of Landau damping is developed which explains the decrease of E with time in terms of the drifting dispersal of an initially localized inhomogeneity. (auth)

33429 WAVES IN COLLISIONLESS PLASMAS. I. TRANSVERSE WAVES. Levin, Joel M. (General Electric Co., King of Prussia, Pa.). Phys. Fluids, 10: 1298-1306(June 1967).

Using the exact solution of the collisionless Boltzmann equation, Maxwell's equations are written in integro-differential form. For transverse waves in an infinite, nonrelativistic plasma, where the forces exerted by the induced magnetic fields are negligible, these equations can be solved without approximations; in this case the electric field, $E(z,t)$, can be expressed for all $-\infty < z < \infty$ and $0 < t < \infty$ as the definite integral over all space of a Green's function operating on the initial fields, $E(z,0)$ and $\dot{E}(z,0)$. The relation between the Fourier–Laplace transform of this Green's function and the dispersion relation is displayed, and the dispersion relation is solved in closed form for ω as a function of the complex phase velocity, ω/k. For an initially Maxwellian plasma ω is expressed in closed form as a function of k for all k. A rigorous proof is given that these waves cannot grow. Investigation of the spatial dependence of an externally driven field shows that in general the roots of the dispersion relation (when solved for k as a function of ω) cannot be identified as complex wave numbers of a damped exponential. Discrepancies between these results and Enoch's earlier treatment of this problem are discussed. (auth)

33430 MEASUREMENT OF EMISSION AND ABSORPTION OF RADIATION BY AN ARGON PLASMA. Evans, D. L.; Tankin, R. S. (Northwestern Univ., Evanston, Ill.). Phys. Fluids, 10: 1137-44(June 1967).

Volumetric radiative loss measurements, correlated with temperature in the range of 10,000 to 26,000°K, have been made on an argon plasma. Pressures of 0.5, 1.0, and 2.0 atm have been used. The 1.0-atm measurements have been corrected for both absorption and ultraviolet emission and the results agree with those of

Emmons in the common temperature range. The 6965 Ar I line has also been studied yielding lineshifts, halfwidths, absorption and emission coefficients. The line shift and halfwidth results are below theoretical predictions. Transition probabilities determined for both emission and absorption studies are found to be in reasonable agreement. (auth)

33431 MAGNETIC MOMENT UNDER SHORT-WAVE ELECTROSTATIC PERTURBATIONS. Taylor, J. B. (United Kingdom Atomic Energy Authority, Culham, Eng.). Phys. Fluids, 10: 1357-9(June 1967).

In the presence of an electrostatic wave the quantity $\mu_0 = v_\perp^2/B$ is no longer an approximate invariant, contrary to the conclusion of earlier authors. The real invariant is calculated and an anomaly in minimum-B stability theory is thereby removed. (auth)

33432 TRANSITION BETWEEN LANDAU AND VAN KAMPEN TREATMENTS OF THE VLASOV EQUATION. Grant, Frederick C. (Langley Research Center, Hampton, Va.); Feix, Marc R. Phys. Fluids, 10: 1356-7(June 1967).

The introduction of small Fokker–Planck damping into the Fourier–Hermite representation is shown to produce, in the proper limit, both the Van Kampen and Landau treatments. This damping removes the difficulties encountered in numerical integration. (auth)

33433 BREMSSTRAHLUNG AND RECOMBINATION RADIATION OF ATOMIC AND IONIC OXYGEN. Morris, J. C.; Krey, R. U.; Bach, G. R. (Avco Corp., Wilmington, Mass.). Phys. Rev., 159: 113-19(July 5, 1967).

Continuum-radiation measurements of an oxygen plasma are presented for a wavelength range from 3000 to 9600 Å and for temperatures from 9000 to 14000°K. The plasma was generated in a mechanically constricted dc arc run at atmospheric pressure. A comparison of the experimental data with theoretical predictions for the positive-ion radiation of Burgess and Seaton and for the negative-ion cross sections of Moskvin was made by a temperature-dependence curve-fit method. (auth)

33434 COLLISIONLESS SHOCK WAVE IN A PLASMA. Niu, Keishiro; Hung, Ru-Jane (Osaka Univ.). J. Phys. Soc. Jap., 23: 436-44(Aug. 1967).

An analysis is developed by the extension of Morawetz's method. One of the assumptions which is different from Morawetz's is the following; the ion and the electron have the same temperatures at $x = -\infty$, in the uniform flow at far upstream. The analysis shows that the shock thickness is of order of the geometric mean of the gyroradii of the ion and the electron at $x = -\infty$. Inside the shock, an electric field is induced by charge separation. This field causes the drift of electrons along the shock surface. Current by this drift of electrons increases the intensity of the magnetic field. Some of the ions are expected to bounce many times at the front of the shock because of the existence of the electric field induced by the charge separation. As a result, they are expected to have large velocities in the neighborhood of the shock. These bouncing ions contribute to produce asymmetric fields before and after the shock wave. (auth)

33435 EXPERIMENTAL STUDY OF ELECTROSTATIC ION CYCLOTRON WAVES IN A PLASMA. Sato, Teruyuki; Matsuura, Kiyokata; Miyahara, Akira; Nagao, Shigeo (Univ. of Nagoya, Japan). J. Phys. Soc. Jap., 23: 378-97(Aug. 1967).

Resonance peaks observed near the ion cyclotron harmonics ($n \leq 5$) of H^+, H_2^+ and H_3^+ are studied in a low density plasma column. According to the dependences on rf voltage applied across a plasma column and electron temperature of the resonance frequency, it is conjectured that the behavior of these resonances is caused by the electrostatic ion cyclotron waves propagating almost perpendicular to the magnetic field. Ions collected by ion collectors and electrodes are accelerated perpendicularly up to 3 keV, while the electron temperature displays little increase. The observed plasma loading indicates that the efficiency of power transfer between the electrodes and the plasma is greater than 50 per cent. (auth)

33436 GROUND STATE OF THE CHARGED BOSE GAS. Bhatia, M. S. (Univ. of Windsor, Ontario). Nuovo Cim. (10), 50B: 173-5(July 11, 1967).

A variational calculation of the ground-state energy of a charged Bose gas, based on a combination of the Girardeau and the modified BP methods, is reported. These calculations yielded better results at the intermediate densities than those obtained by Girardeau's variational procedure. (M.O.W.)

33437 ON THE COLLISION TERM OF THE BOLTZMANN EQUATION FOR A LORENTZ GAS. Pozzoli, R. (Univ., Milan, Gruppo Nazionale di Elettronica Quantistica e Plasmi, Milan). Nuovo Cim. (10), 50B: 137-48(July 11, 1967).

The expansion of the collision term of Boltzmann's equation for a Lorentz plasma in the parameter $\epsilon = (m/M)^{1/2}$ (m and M being the electron and neutral mass, respectively) is performed up to second order. Every term is then expanded in spherical harmonics of the electron velocity. The neutral distribution function is assumed to be completely arbitrary. As an application a diffusion equation has been deduced for the electrons in a constant magnetic field and with an arbitrary initial condition for the neutrals. (auth)

33438 OSCILLATIONS OF AN INHOMOGENEOUS CYLINDRICAL PLASMA COLUMN. Krishan, S. (Univ. of Alberta, Edmonton); Rao, S. Singh. Nuovo Cim. (10), 50B: 129-36(July 11, 1967).

The oscillations of an inhomogeneous cylindrical plasma column with perturbations of the form $\exp[i(m\varphi + kz - \omega t)]$ have been studied, where m is the azimuthal wave vector and k the wave vector parallel to the axis of the cylinder. A density-independent mode $|\omega|/\Omega_i \simeq 1$ has been found which agrees with the experimentally found value, where Ω_i is the ion cyclotron frequency. (auth)

33439 WAVE EXCITATION IN PLASMA BY EXTERNAL CURRENTS. I. Murmylo, G. L. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 735-40(May 1967). (In Russian).

The excitation of high-frequency and low-frequency waves in boundless homogeneous plasma by external currents is considered. A general expression for wave excitation intensity in a plasma transparency range for both isotropic and anisotropic plasma is obtained. Excitation of waves by modulated axial, azimuthal, and radial currents is investigated for isotropic plasma. Expressions for differential and integral intensities of excited waves are obtained. High-frequency and low-frequency resonances are studied. (auth)

33440 EXCITED ATOMS IN DECAYING OPTICALLY THICK PLASMAS. Bates, D. R.; Bell, K. L.; Kingston, A. E. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 91: 288-9(June 1967).

With attention confined to decaying hydrogen and helium plasmas which are optically thick towards lines ending on the ground level, the quasi-equilibrium number density of atoms in the first excited level $n_q'(2)$ is computed using collisional deactivation coefficients K(2,1) based on experiment and taking Penning ionization into account. This is discussed in some detail. Quantal calculations are carried out on the rate at which the electronic transitions involved in $2H(2s\text{-}p) \rightarrow H(1s) + H^+ + e$ occur. It is concluded that the rate is probably fast enough for almost all close collisions to lead to ionization. This also seems to be the case for $2He(2\,^3S) \rightarrow He(1\,^1S) + He^+ + e$ provided collisions which can yield ionization only by violation of Wigner's spin conservation rule are excluded from consideration. Penning ionization is of little importance in hydrogen plasmas, but it can be significant in helium plasmas, where it tends to reduce $n_q'(2)$ and the apparent recombination coefficient. (auth) (UK)

33441 REFLECTION AND TRANSMISSION OF ELECTROMAGNETIC WAVES BY A MOVING PLASMA MEDIUM. II. PARALLEL POLARIZATIONS. Yeh, C. (Univ. of California, Los Angeles). J. Appl. Phys., 38: 2871-3(June 1967).

The reflection and transmission of electromagnetic waves by a moving dispersive dielectric half-space or slab are investigated theoretically. The dispersive medium is assumed to be a cold plasma medium. Two cases of the movement are considered: (a) the plasma medium moves parallel to the interface; (b) the plasma medium moves perpendicular to the interface. The electric vector of the incident wave is assumed to be polarized in the plane of incident (parallel polarization). Unlike the normal polarization case which was treated earlier, the reflected and transmitted fields for the present case are functions of the velocity of the moving plasma medium for both cases (a) and (b). An illustrative numerical example is given for case (a) at normal incidence. (auth)

33442 STEADY-STATE THEORY OF AN INTERMEDIATE-PRESSURE DISCHARGE COLUMN IN A MAGNETIC FIELD. Ewald, H. N.; Crawford, F. W.; Self, S. A. (Stanford Univ., Calif.). J. Appl. Phys., 38: 2753-61(June 1967).

A steady-state theory of a discharge column in a magnetic field is presented which covers the intermediate pressure range where the ion mean free path is neither much greater than, nor much less than, the discharge radius. With increasing pressure and magnetic field, its predictions tend to those obtainable from ambipolar diffusion theory. With decreasing pressure they approximate those of low-pressure discharge theory based on the use of the third-moment equation for the ions. The analysis is based on continuity and momentum-transfer equations for the electrons and ions, but in contrast to linear ambipolar diffusion theory, the nonlinear ion inertia term is retained. In the plasma approximation, retention of this term gives rise to a plasma-sheath boundary, where the den-

sity is nonzero and the potential finite, located where the ambipolar drift velocity reaches the isothermal sound speed $[k(T_e + T_i)/m_i]^{1/2}$. Numerical solutions are presented for the profiles of density, velocity, and potential, for planar and cylindrical discharges. These indicate that potential inversion can occur, and that under such conditions the potential rises to a maximum and then decreases towards the plasma-sheath boundary. (auth)

33443 SLOW-WAVE PARAMETRIC PUMPING OF THE ELECTROSTATIC WAVE IN A PLASMA. Paik, S. F. (Electronics Research Center, Cambridge, Mass.). J. Appl. Phys., 38: 3003-7(June 1967).

The electrostatic wave in a plasma may be amplified parametrically by applying a pump power at microwave frequencies. The theory of the parametric interaction between the electrostatic wave and a guided electromagnetic wave is presented, and the gain parameter is derived in terms of the pump power. The pump power required to observe the effect of the pumping at microwave frequencies is calculated to be orders of magnitude less than the optical power required to produce the Raman effect in plasmas. (auth)

33444 HYDRODYNAMIC DESCRIPTION OF PLASMAS IN THE FRAME OF BBGKY–HIERARCHY. Klassmann, W. (Univ., Cologne). Z. Phys., 204: 83-100(1967). (In German).

Following a method usually applied in the case of the Boltzmann equation, moment equations are introduced, starting from the first two equations of the BBGKY hierarchy. The short-range interactions between the neutral and ionized (neutral) particles are treated approximately. The so-constructed system of equations contains a set of equations, which are often used for the description of a plasma, for instance, the fundamental equations of the Debye–Hückel theory of electrolytes and the so-called force equation of Schlüter. As a simple application the charge distribution around an ionized particle is calculated when an external electrical field is present. (auth)

33445 USE OF CONDITIONAL DISTRIBUTION FUNCTION IN THE THEORY OF GAS PLASMA. Hoevel, F.; Klassmann, W.; Sauter, F. (Univ., Cologne). Z. Phys., 204: 71-82(1967). (In German).

For the so-called "conditioned" distribution functions, derived from the distribution functions used in the BBGKY hierarchy, a certain ansatz is made, the consequences of which are investigated. As an application a simple example is discussed, namely the problem of the charge distribution around an ionized particle in presence of an external electrical field. (auth)

33446 NONLINEAR INCOHERENT LIGHT SCATTERING. Salat, A. (Institut fuer Plasmaphysik GmbH, Garching, Ger.). Z. Naturforsch., 22a: 662-70(May 1967).

Classical equations are used to calculate nonlinear incoherent light scattered from two coherent beams of electromagnetic radiation of different frequencies propagating in a homogeneous plasma without magnetic field. With a suitable choice of the difference frequency, enhanced light scattering occurs near the plasma frequency. In this case the frequency spectrum is mainly given by the thermal ion density fluctuations. (auth)

33447 INFLUENCE OF DISPERSION EFFECTS ON THE STRUCTURE OF A SHOCK WAVE IN A MAGNETIZED PLASMA. Eselevich, V. G.; Kurtmullaev, R. Kh.; Pil'skii, V. I. JETP Lett. (USSR) (Engl. Transl.), 5: 255-7(May 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 311-14(May 1, 1967).

In the experiments a plasma was placed in a quasi-stationary magnetic field and subjected to fast compression by an alternating magnetic field applied to its boundary. The associated instabilities and discontinuities are briefly discussed. (M.O.W.)

33448 INVESTIGATION OF FAST IONS, APPEARING DURING INTERACTION OF RUN-AWAY ELECTRONS WITH PLASMA. Sukhomlin, E. A.; Suprunenko, V. A.; Krupnik, L. I.; Reva, N. I.; Demchenko, P. A.; Tyupa, V. I.; Sakharov, A. A. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 12: 507-8 (Mar. 1967). (In Russian).

An intense microwave emission, an increase in discharge resistance, and plasma electron heating were previously observed for beam instabilities produced by electron interactions with plasma in strong electric fields. It was also previously shown that strong plasma heating at the expense of ion–acoustic oscillations may take place in strong electric fields. Studies were made of fast ions produced by instabilities excited by escaping electrons in a strong-flow rectilinear gas discharge stabilized by magnetic fields. The studies included the longitudinal and transverse current (in relation to magnetic field) of particles escaping from the discharge. Direct measurements were made of fast neutral hydrogen atom flow, which upon passing through the gas chamber was transformed into ions. The ions were analyzed according to their energies using a plane condenser. Oscillograms of the general discharge current and ion current along the magnetic field recorded at 1-μsec intervals and a curve of longitudinal ion current as a function of the charge intensity (at 1 keV particle energy) are included. (R.V.J.)

33449 PENETRATION OF A LONGITUDINAL ELECTRIC FIELD INTO A LIMITED MAGNETO-ACTIVE PLASMA. Kondratenko, A. N. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 12: 379-89(Mar. 1967). (In Russian).

The kinetic approximation is considered for the penetration of a longitudinal electric field in a layer of plasma situated in a direct magnetic field parallel to the plasma boundary. General expressions are found for the field in the plasma; the case of a potential field in the approximation of a weak and strong spatial dispersion is considered for high- and low-frequency oscillations. The resonance frequencies are determined in the case of spatial resonances. (auth)

33450 EXPANSION THEOREM FOR THE LINEARIZED FOKKER–PLANCK EQUATION. Lewis, Jordan D. (Univ. of Michigan, Ann Arbor). J. Math. Phys. (N. Y.), 8: 791-8(Apr. 1967).

The linearized Fokker–Planck kinetic equation for each component of a homogeneous, nondegenerate, fully ionized plasma is separated by means of a spherical harmonic expansion into an infinite set of singular integro–differential equations. Each equation is shown to generate a continuous set of eigenfunctions, for which asymptotic high-speed forms are found. By extending the theory of singular differential equations an expansion formula is developed, which is shown to be complete with respect to functions square integrable in velocity space. (auth)

33451 ANALOG TO THE SAHA EQUATION FOR RECOMBINING HIGH-PRESSURE PLASMAS IN WHICH THE ELECTRON TEMPERATURE EXCEEDS THE GAS TEMPERATURE. Collins, C. B. (Southwest Center for Advanced Studies, Dallas). Phys. Rev., 158: 94-6(June 5, 1967).

The question of steady-state populations produced by a balance of heavy-particle collisional ionization against its inverse is considered. An analog to the Saha equation is derived which is useful in estimating the populations of excited states with high quantum numbers expected in plasmas recombining at high neutral pressures and electron temperatures in excess of the heavy-particle temperature. (auth)

33452 PHENOMENA IN THE CATHODE REGION OF AN MPD ACCELERATOR. Malliaris, A. C. (Avco Corp., Wilmington, Mass.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 1325-8 (July 1967).

An axisymmetric MPD accelerator is considered. The self-induced magnetic compression of the plasma in the electrical discharge results, generally, in an overpressure at the cathode tip. The overpressure, Δp, increases almost linearly with the square of the current I when no external magnetic field B is present. This relationship has been used for the experimental determination of the discharge radius at the cathode. However, when a B field is applied along the axial direction, the overpressure under consideration is drastically reduced and, for sufficiently large B, it becomes negative. In such a case, no simple relationship exists between the discharge current and the cathode-tip overpressure. The reasons for this are discussed and the relevant phenomena are experimentally and analytically examined for a steady-state electrical discharge. The discharge in question (currents up to 2500 amp) takes place between two axisymmetric electrodes, in the presence of an axial B field (0 to 2000 gauss) and a nitrogen flow at rates between 0.10 and 0.40 g/sec. (auth)

33453 INTERACTION OF RELATIVISTIC PARTICLES WITH MAGNETIC FIELDS. Manley, Oscar P. (American Science and Engineering, Cambridge, Mass.). Phys. Rev., 157: 1232-3(May 25, 1967).

It is shown that the energy dissipated by a charged particle and a magnetic field containing it exceeds the initial energy of the particle. The deficiency in the energy balance, which is comparable with the initial energy of the particle, is made up by a corresponding decrease in the magnetic field energy. Quantitatively, the change in the field energy is independent of the mode of dissipation. Possible consequences of this result, such as increased relaxation rates of magnetic fields in magnetoactive plasmas, are indicated. (auth)

33454 ACOUSTIC WAVE MODE IN A WEAKLY IONIZED GAS. Ingard, Uno; Schulz, Michael (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 158: 106-12(June 5, 1967).

The acoustic wave mode in a weakly ionized gas, which is a perturbed version of an ordinary sound wave in a neutral gas, is investigated. At sufficiently low frequencies, $\omega \ll \omega_c = \Omega_n(N_n/N_i)$

(T_n/T_e), the acoustic oscillations of the electrons, ions, and neutrals are all in phase and have equal amplitudes (N_n = neutral-particle density, N_i = ion-particle density, T_n = neutral temperature, T_e = electron temperature, Ω_n = collision frequency of a neutral particle with charged particles). However, at frequencies of the order of or larger than ω_c, a marked phase difference between the oscillations of the different fluid components occurs. This leads to charge separation and an electro-acoustic effect, i.e., an electric-field perturbation produced by a sound wave. Previously reported wave amplification, predicted on the assumption that all particle species oscillate in phase, is found to be consistent with the dispersion relation derived here at frequencies $\omega \ll \omega_c$. At frequencies $\omega \geq \omega_c$, a reduction of the amplification takes place. As a consequence it is shown that, contrary to what previously has been believed, a decrease of the neutral-gas temperature does not always lead to an increase in the wave amplification. (auth)

33455 GENERALIZED FOKKER–PLANCK KINETIC MODEL. Gross, E. P. (Brandeis Univ., Waltham, Mass.). Phys. Rev., 158: 146-53(June 5, 1967).

Some consequences are studied of a nonlinear kinetic model that has the structure of a constant-collision-time, Fokker–Planck equation. The collision operator, however, satisfies momentum and energy conservation in addition to particle conservation. One can find the relaxation spectrum for the nonlinear as well as linear problem. It consists of an infinite sequence of decays with the spectrum of the quantum harmonic oscillator. It is also possible to solve exactly the initial-value problem for the linearized kinetic equation. The Green's function for the complete operator obeys a degenerate integral equation containing the Green's function of the usual Fokker–Planck equation. The exact time-dependent density correlation function is found and thus the inelastic scattering cross section that determines the neutron scattering and the Brillouin scattering of light from the system. (auth)

33456 ANALYSIS OF COMPRESSIBLE PLASMA CONTAINED IN A WAVEGUIDE. Sancer, Maurice Irving. Cleveland, Case Inst. of Tech., 1965. 115p.

Thesis.

The analysis of a compressible plasma which is contained in a waveguide of general cross section is presented. The plasma is described by the linearized multifluid equations and the source terms are allowed to be quite general. Anisotropic effects which are caused by the presence of an externally applied constant axial magnetic field are included. Two distinct approaches are used in the analysis of these equations. The first is classical and the second considers the system of equations as a linear operator and presents a formal spectral representation of this operator. For both approaches the electron fluid model is treated in considerable detail and then the analysis is generalized to be applicable to the multifluid model. Finally, a general set of boundary conditions is presented and is shown to guarantee that a solution to linearized multifluid equations which satisfies these boundary conditions is unique. The boundary conditions which are used because of physical considerations are shown to belong to this set of mathematically meaningful boundary conditions. (Disser. Abstr.)

33457 MEASUREMENT OF ENERGETIC TEST ELECTRON INTERACTIONS WITH A PLASMA. Smith, Michael Robert. Cleveland, Case Inst. of Tech., 1965. 83p.

Thesis.

An experimental determination is made of the distribution of energy losses suffered by a beam of energetic test electrons traversing a dense, high-temperature plasma. The test electron energy is 3,000 electron volts and the plasma density varies from 5×10^{15} to 1×10^{16} cm^{-3} at a temperature of ~40,000°K. A collisional theory is developed through the ad hoc extension of the maximum impact parameter, $P_{max} = \lambda_D V/W_t$, and agreement is found with the results of various other authors. The experimental average energy loss is larger than the theoretical prediction, indicating a minimum discrepancy of approximately an order of magnitude between theory and experiment. The experimental average energy loss and spread in energy are both found to vary proportional to the plasma electron density. The experimental measurements do not substantiate a proposed energy gain mechanism. (Disser. Abstr.)

33458 GROWTH OF FLUCTUATIONS IN A COLLISIONLESS PLASMA SUBJECTED TO AN ELECTRIC FIELD. Linson, Lewis Martell. Stanford, Calif., Stanford Univ., 1966. 226p.

Thesis.

An analytic representation of the time behavior of the fluctuating fields $E_k(t)$ in a nonstationary, collisionless plasma is derived. The specific case treated is that of a uniform, constant electric field E_0 which is large enough to excite the two-stream instability when applied to a uniform plasma. The basic equation solved is the inhomogeneous Volterra integral equation for the fluctuating electric fields derived by Fried et al., on the basis of the linearized Vlasov equation. The technique developed is applicable for plasmas whose velocity distribution functions lead to a polynomial dispersion function; the integral equation can then be converted into an inhomogeneous differential equation for the fluctuating fields. The cold plasma and a plasma whose velocity distribution functions are resonance-shaped are discussed; the resulting differential equations are of fourth-order. Besides being capable of dealing with more general distribution functions, the technique can also be generalized to include nonsteady applied fields as well as situations in which the relative velocity between the species comprising the plasma has arbitrary time behavior. (TSS) (Disser. Abstr.)

33459 INVESTIGATION OF DENSE PLASMA UNDER A STRONG ELECTRIC FIELD. Mendel, Clifford William Jr. Urbana, Ill., Univ. of Illinois, 1966. 76p.

Thesis.

A hydrogen plasma of density ~10^{16} cm^{-3} and electron temperature ~200 eV has been investigated under electric fields of 100 to 500 V/cm. A pinch of pinch ratio ~3 was found to be hydrodynamically stable for ~2 μsec during which the experiment was performed. A sharp burst of runaway electrons of total current of the order of amperes occurred and disappeared shortly after conduction began. Large low-frequency oscillations believed to be ion–acoustic oscillations appear and give rise to very high resistivities in qualitative agreement with recent theories on plasma conductivity. (Disser. Abstr.)

33460 EXPERIMENTAL STUDY OF THE RELATIONSHIP BETWEEN MOVING STRIATIONS AND PLASMA-ACOUSTIC WAVES. Meskan, David Allan. Cleveland, Case Inst. of Tech., 1965. 96p.

Thesis.

The velocity, attenuation, and frequency of moving striations in the positive column of a hot-cathode glow discharge are determined experimentally. Plasma–acoustic wave dispersion relations which would be appropriate for explaining these striations by means of a linear fluid model are derived. The properties of various large amplitude waves predicted by nonlinear fluid models are discussed. A comparison of the striations' behavior and the plasma–acoustic wave theories demonstrates that the frequently assumed relationship between these two phenomena does not exist. The experiments were performed in an argon discharge at pressures from 20 to 480 mtorr and with discharge current densities on the order of 25 mA/cm^2. Typical electron densities and temperatures were 2×10^{10} cm^{-3} and 2×10^{4}°K. The velocity of the striations varied from 2.1×10^5 to 1.3×10^6 cm/sec, while the frequency varied from 6×10^2 to 2.3×10^4 cycles per second. (Disser. Abstr.)

33461 DYNAMICS OF A THETA PINCH DISCHARGE IN A TRANSVERSE MAGNETIC FIELD. Lee, William Leung Him. Vancouver, B. C., Univ. of British Columbia, 1966.

Thesis.

The suppression of radial hydromagnetic oscillations of a theta-pinch plasmoid produced in air has been investigated with magnetic probes and a framing camera. In the presence of essentially static and uniform magnetic bias fields (produced by Helmholtz coils) it was found that the oscillations are suppressed by a flip instability of the plasmoid and the direction of flip is controlled by the transverse magnetic field. Using the suppression of radial hydromagnetic oscillation as the criterion for flip, it is found experimentally that if $B_T/ap^{\frac{1}{2}}$ is greater than a critical value, then the plasma ring flips. "B_T" is the strength of the bias field perpendicular to the axis of the theta coil, "a" the radius of the discharge vessel and "p" is the gas pressure. The experimental results are interpreted in terms of a snowplough model for the discharge, in which the plasma current forms two concentric cylinders. The predictions of the theory agree with the experimental observations. (Disser. Abstr.)

33462 EXPERIMENTAL OBSERVATIONS OF THE STRUCTURE OF SHOCK WAVES IN A COLLISION-FREE PLASMA. Goldenbaum, George Charles. College Park, Md., Univ. of Maryland, 1966. 92p.

Thesis.

Radial shock waves are generated in a 10-cm-diameter cylindrical hydrogen plasma. The initial conditions are $kT_e = 1.4$ eV, $n \cong 2$ to 3×10^{14} cm^{-3}, $B_{ax} = -650$ G. Shock waves with an Alfven Mach number of about 3 are generated by a fast rising axially directed field of amplitude +5 kG. Magnetic probe measurements show that the thickness of the magnetic transition is about 1 cm. Spectroscopic observations of the appearance of lines from carbon impurities in the plasma indicate that the electrons are rapidly heated to 50 eV or more in the leading edge of the magnetic transi-

tion. The electrons are heated in a time short compared with the deflection time for electron–ion collisions. The transition takes place over a length shorter than the ion gyroradii, the ion–ion or the ion–neutral mean free path for ions in the wave front. These results agree with a simple model in which the electrons are heated in front of the observed magnetic disturbance and the structure of the magnetic field transition is determined by collisions of the electrons with ion waves, or by an ion wave instability. (Disser. Abstr.)

33463 PLASMA VORTICES IN THE COAXIAL ACCELERATOR. Farber, Elliot. Hoboken, N. J., Stevens Inst. of Tech., 1966. 103p.
Thesis.
The flow of plasma in a coaxial accelerator of large aspect ratio and with center conductor negative is studied with a variety of diagnostic techniques. Measurements of radial current density, azimuthal magnetic field, radial and axial electric fields, ion density and plasma flow density are utilized to detect and study plasma vortices behind the current sheet. The most salient characteristic of the plasma vortex is the rotation of plasma without shear as in the ideal hydrodynamical vortex core. A model of the plasma vortex based on the guiding center equations is constructed. Agreement between this model and experimental results is favorable. (Disser. Abstr.)

33464 OSCILLATIONS IN THE PLASMA SHEATH. Schwartz, Simon H. Brooklyn, Polytechnic Inst. of Brooklyn, 1966. 69p.
Thesis.
A theoretical investigation is conducted into the behavior of the ion plasma sheath next to a wall under a sinusoidal-in-time perturbation of the potential of the wall. The analysis includes the effects of electron–neutral particle collisions in a sheath. The linearized macroscopic plasma equations are taken to be applicable here, and a perturbation procedure is employed in order to obtain an equation for the propagation of the perturbation. A theoretical analysis of the equation for the perturbation is carried out in order to obtain qualitative results, and a numerical analysis is performed in order to obtain quantitative results. It is concluded that oscillations in the plasma sheath are possible, and that two resonances should exist at frequencies below the asymptotic plasma frequency. It is further concluded that the failure of some observers to find these resonances experimentally may have been due to the effect of collisions. (Disser. Abstr.)

33465 EXPERIMENTAL INVESTIGATION OF PLASMA VORTICES INJECTED BY A CONICAL COIL INDUCTION ACCELERATOR INTO A UNIFORM GUIDE FIELD. Small, Robert Loring. Hoboken, N. J., Stevens Inst. of Tech., 1966. 147p.
Thesis.
An experimental investigation of the local magnetic field, ion density flow, and electric field has been made in the downstream plasma generated by a one-turn conical coil induction accelerator. From data obtained with small directional probes, certain gross features of the plasma structure, as a function of its downstream position, are inferred. Biased double probes are used to determine the directed ion velocity and density of the plasma. Magnetic probes are used to obtain the plasma-generated magnetic fields, from which the currents in the plasma are deduced. Electric field probes were used with limited success to determine the plasma E-drift flow for comparison with the other probe data. The ion flow and plasma currents show the existence of a series of axisymmetric magnetohydrodynamic vortices close to the conical coil. The plasma currents quickly dissipate and are not discernible beyond 25 cm downstream, except for some diamagnetic currents. The dissipative mechanism for the currents associated with the vortex configuration has not been carried out. Those vortices that have poloidal ion motion opposed to the direction of propagation of the plasma appear to expand, coalesce, and dissipate, while some of the vortices that have poloidal ion motion in the direction of propagation persist for the total 85-cm distance measured. These vortices move at a constant velocity slightly less than 1 cm/μs. The bulk of the plasma is confined to less than an 8-cm radius, and varies from a maximum density of 10^{15}/cm^3 near the conical coil to a maximum density of 10^{14}/cm^3 at 85 cm downstream. (TSS) (Disser. Abstr.)

33466 WAVEGUIDES FILLED WITH MAGNETOPLASMAS OF VARIOUS TYPES. Akkaya, Inci. Urbana, Ill., Univ. of Illinois, 1966. 179p.
Thesis.
Wave propagation in a linearized, homogeneous magnetoplasma of bounded and unbounded regions has been investigated in detail. Plasmas of various models are considered in order to evaluate the effects of electron temperature and of the resonances on the waves. Three models are studied: the usual incompressible model, the compressible fluid model and a microscopic model. The second model is based on the transport equations and the third on the Boltzmann equation with an assumed Maxwellian velocity distribution at equilibrium. (TSS) (Disser. Abstr.)

33467 APPLICATION OF FINITE-DIFFERENCE TECHNIQUES TO ULF WAVES IN A SPHERICAL MODEL INHOMOGENEOUS, ANISOTROPIC, ATMOSPHERIC PLASMA. Chapman, Carroll Winston. Austin, Tex., Univ. of Texas, 1966. 247p.
Thesis.
Some interesting and significant problems which arise currently in the study of earth-observed ulf micropulsation signals are concerned with the interpretation of the data by means of mathematical modeling techniques. The difficulty involved in model analysis lies in the fact that the linearized equations which govern the field distributions in the terrestrial outer atmospheric medium do not yield to classical analytical methods of solution unless the medium submits to a compromise or neglect of some of its salient features. The work reported here resulted from an investigation of the possibility of treating a more realistic model than has been considered heretofore by means of the application of elementary finite-difference techniques. A finite-difference analog of the differential equations which describe the propagation of electromagnetic waves in the medium is formulated in spherical coordinates and numerical results of field distributions in the medium are presented. In order to show that the difference equations are consistent with the system of differential equations, elementary physical and mathematical considerations are applied to certain special cases of the results to qualitatively verify the salient features of the field distributions. The propagation medium is two-dimensionally inhomogeneous and consists of a plasma gas in the presence of a static dipole magnetic field. An infinitely conducting spherical earth is embedded in the plasma. The medium is bounded at its outer extreme by a spherical boundary. The various modes of propagation are classified according to the symmetry conditions which are consistently allowed at the geomagnetic poles and equator. All of the calculated results are derived using a lossless plasma and rather arbitrarily assigned boundary conditions. (Disser. Abstr.)

33468 DYNAMICS OF A Z-PINCH DISCHARGE IN ARGON. Daughney, Cecil Charles. Vancouver, B. C., Univ. of British Columbia, 1966.
Thesis.
A discussion of probe measurement of the magnetic field in a plasma is presented with particular reference to the perturbation of the magnetic field caused by the probe. A correction procedure is developed to compensate for this perturbation. Using magnetic probes, radial current density distributions are obtained for an argon plasma in a z-pinch discharge. Initial argon pressures of 100, 250, and 500 μ Hg are investigated. The current density distributions are determined for 1 μsec intervals between the initiation of the discharge and the occurrence of the first pinch. These current density distributions are compared with photographic observations. The experimental results are discussed in terms of the snowplow model and the shock wave model. Mathematically, the non-linear snowplow equation is solved using an approximation technique which results in analytic solutions. The shock wave equation is solved by a graphical technique. An extension of the shock wave model is proposed for a better understanding of the experimental results. (Disser. Abstr.)

Production of Plasma

33469 (CONF-670104-Pt.1, pp 107-8) ON THE IONIZATION OF DENSE GASES. Vedenov, A. A. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii).
It is known that in a rarefied plasma the degree of ionization α is reduced if the gas density n is increased (and the temperature T is held constant). It is shown that in a very dense gas α can grow with the density n. (auth)

33470 (UCRL-70501) THE APPLICATION OF LASERS TO THE PRODUCTION OF HIGH-TEMPERATURE AND HIGH-PRESSURE PLASMA. Kidder, Ray E. (California Univ., Livermore. Lawrence Radiation Lab.). June 16, 1967. Contract W-7405-eng-48. 37p. (CONF-670811-1). Dep. CFSTI.
From Gordon Conference, Crystal Mountain, Wash.
A brief account is given of the historical evolution of giant pulse lasers and of the level of performance of such lasers that has so far been achieved. Those aspects of the interaction of light with a plasma that are of importance in plasma heating are briefly reviewed, and a detailed treatment including the results of computer calculations is given of the heating of a spark within a homogeneous gas, the subsonic heating of an isolated gas sphere, and the pressure resulting from light-induced blowoff. It is concluded that existing giant pulse lasers have sufficient brightness to be potentially capable of producing plasmas with kilovolt temperatures and

tens of megabar pressures, but that a major increase in output power will be required before this potential can be realized. The design of future giant pulse lasers that are particularly well suited to the achievement of extremely high output power at high brightness is discussed. (auth)

33471 DENSITY AND TEMPERATURE OF LASER-PRODUCED PLASMA IN A SPACE CHAMBER. Hirono, Motokazu; Iwamoto, Iwao (Radio Research Labs., Tokyo). Jap. J. Appl. Phys., 6: 1006(Aug. 1967).

The characteristics of charged particles produced by irradiation of a focused giant pulse of about 1300 MW/cm^2 on an aluminum target in the vacuum of a space chamber were studied. The giant pulse of the ruby laser consisted of several pulses grouped in about 300 ns, the total energy being about 0.5 joule. Two circular planar Langmuir probes were used. (M.O.W.)

33472 COMPARISON OF OBLIQUE, NORMAL, AND TRANSVERSE IONIZING SHOCK WAVES. Taussig, Robert T. (Columbia Univ., New York). Phys. Fluids, 10: 1145-61(June 1967).

The jump equations for an oblique ionizing shock wave are examined in detail. A qualitative description of the shock structure helps to eliminate one of the four possible solutions and to limit the electric currents which the remaining shock solutions can carry. The criterion of evolutionarity is applied to ionizing shock waves to obtain necessary conditions for the existence of unique solutions. A shock structure restriction is proven which allows one to define a unique solution for every shock speed. Using these results, the Chapman–Jouguet mode of electromagnetic shock tube operation is justified in the weak-ionizing shock-wave limit. Oblique, normal and transverse ionizing shocks in hydrogen, including the effects of ionization and dissociation, are compared. The temperature, thermalization efficiency, heating time, conversion ratio of magnetic to thermal energies and the specific impulses obtained by such shocks are used as measures of comparison. The transverse type of shock is shown to be the most effective one for producing a hot plasma sample. Results of several recent experiments are compared to the theoretical predictions, and the accuracy of the shock model and conclusions drawn from it are criticized briefly. (auth)

33473 LASER-DRIVEN DETONATION WAVES IN GASES. Daiber, J. W.; Thompson, H. M. (Cornell Aeronautical Lab., Buffalo). Phys. Fluids, 10: 1162-9(June 1967).

The plasma created by the output of a 2- to 10-J Q-switched ruby laser focused into air, argon, helium and hydrogen at pressures from 15 to 1000 psi has been photographically recorded during and after the laser heating pulse. The growth of the luminous plasma front during laser irradiation was in accordance with a prediction based on a radiatively supported detonation-wave model in which a Gaussian pulse shape was used for the instantaneous energy addition. With hydrogen at atmospheric pressure an appreciable fraction of the laser energy was transmitted. Consequently, the detonation-wave model had to include only partial absorption of the incident laser beam. This was done by using the inverse bremsstrahlung absorption coefficient and a constant depth of energy addition. The shock wave created by this sudden energy addition was observed by using a Schlieren system. The growth of the shock wave was not in accordance with that predicted by spherical-blast-wave theory. The shock-wave position from the initial point of breakdown varied as time from breakdown to the (0.20 ± 20%) power independent of gas species or operating condition. (auth)

33474 PHENOMENON OF AUTOIONIZATION WITH DISTURBANCE OF THE INTERCOMBINATION PROHIBITION IN PLASMA. Grechikhin, L. I. (Inst. of Physics, Minsk). Dokl. Akad. Nauk BSSR, 11: 214-16(Mar. 1967). (In Russian).

On the basis of the concept on the formation of superposition of states as a consequence of spin–spin interaction of incident electrons with bound electrons, a general phenomenological theory of the phenomenon of autoionization with disturbance of the intercombination prohibition is given. The dependence of the relation of the intensity of the autoionization and nonautoionization of rays on the concentration of charged particles is shown. For rays which have a high probability of autoionization with increase of the concentration of charged particles this comparative intensity increases, and for rays with less probability of autoionization it decreases. The good agreement with experimental results is shown on the example of the 4587 Å copper line. (tr-auth)

33475 INFLUENCE OF A RADIAL MASS CURRENT ON ELECTRIC ARCS. Druxes, H.; Schmitz, G.; Patt, H. J. (Technische Hochschule, Aachen). Z. Phys., 203: 192-213(1967). (In German).

The influence of a radial instreaming gas on electric arcs is investigated. An axial or an azimuthal mass flow may be superimposed to the radial one. Using the basic equations of the single-fluid model of plasma physics the important properties and parameter dependences are numerically calculated and discussed. The results are compared with those of a corresponding arc without an instreaming radial mass flow. Using an arc heater with radial mass flow it is possible to reach much higher axis temperatures and enthalpy densities. Choosing a set of well selected working conditions nearly the whole electric input may be transformed into axial enthalpy flux of the gas to be heated. The mutual interaction between the dynamic and thermic functions of an electric arc is illustrated. (auth)

33476 STUDY OF THE DIFFERENT OPERATING MODES OF AN ALKALI-METAL-PLASMA MACHINE BY MEANS OF ELECTRIC PROBES. Felden, M.; Haug, R.; Schirmann, D. (Univ., Nancy). J. Appl. Phys., 38: 2853-64(June 1967).

The design of a fully demountable alkali-metal-plasma machine is discussed. The plasma is produced by contact ionization of alkaline metal vapor on a refractory metal emitter. The properties of this plasma depend on three parameters: emitter temperature, cesium vapor pressure, and potential of an electrode which sets the electric boundary conditions for the medium. Three movable probes analyze the plasma. Measurements are made and results are discussed in terms of the parameters. The first part of the study is devoted to a description of the machine and the probes. The second part analyzes its different operating modes. There are two fundamental modes. The first covers the case where collisions are predominant. The second is a flux mode in which interactions are very improbable. The machine permits continuous transition from the first to the second mode. In the transition zone complex phenomena arise. The study is primarily concerned with an examination of the inflection potentials given by the second derivative of the current–voltage characteristics of the probes. Interpretation of this inflection potential will differ greatly from one operating mode to another. (auth)

33477 BREAKDOWN MECHANISMS FOR LASER-INDUCED PLASMAS IN SUPER-HIGH PRESSURE GASES. Gill, Dennis Howard. Austin, Tex., Univ. of Texas, 1966. 136p.

Thesis.

Possible mechanisms responsible for laser-induced breakdown in super-high-pressure gases are investigated both theoretically and experimentally. It is shown that the breakdown mechanism involves energy gain of free electrons by acceleration in the incident electromagnetic field while undergoing collisions with neutrals, and subsequent electron-impact ionization. This mechanism is described by classical microwave breakdown theory and favorably compares with the experimental measurements. Experimental breakdown threshold data in He, Ar, H_2, and N_2 were obtained over the pressure range 100 to 30,000 psi. (TSS) (Disser. Abstr.)

Stability of Plasma

33478 (CLM-R-69) ION CYCLOTRON INSTABILITIES IN THE PHOENIX APPARATUS. Cordey, J. G.; Kuo-Petravic, L. G.; Murphy, E. G.; Petravic, M.; Sweetman, D. R.; Thompson, E. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Jan. 1967. 9p. (CONF-661115-4). Dep. CFSTI, UK 1s. 6d.

From 8th Annual Meeting, American Physical Society, Division of Plasma Physics, Boston, Mass.

Instabilities which are associated with bursts of electrostatic oscillations at, or near, the ion cyclotron frequency and its harmonics are present in the PHOENIX machines both in the simple mirror and in the quadrupole magnetic well configurations. In both cases the instability is accompanied by energy spreading of the initially monoenergetic ion energy distribution though the effect is less marked in the latter. The fields have been resolved into those generated by azimuthal and axial currents and the frequency spectrum of each component has been measured. In the simple mirror the strongest signals are generated by m = 1 azimuthal currents which show characteristic frequency sweeps starting at the ion cyclotron frequency corresponding to the centre of the machine and falling by some 10% in the duration of a burst. In the magnetic well the signals are predominantly due to axial currents and the harmonic structure varies with density. At a density of 10^9 cm^{-3} the signals occur at harmonics of the central ion cyclotron frequency (normally 25 MHz) and a frequency some 3 MHz higher, the fundamental being strongest. As the density is increased the second harmonics increase in intensity until they predominate. Further increase in density brings a sudden change to strong even harmonics and very much weaker odd harmonics. At the highest densities reached (5×10^9 cm^{-3}) bursts at a frequency about 4 MHz lower than the third harmonic appear and are accompanied by a progressive redistribution in plasma density. The results are discussed in the light of present theories (auth)

33479 (CONF-670104–Pt.1, pp 129-36) INVESTIGATION OF INHOMOGENEOUS PLASMA INSTABILITIES. Buchelnikova, N. S.; Salimov, R. A.; Eidelman, Yu. I. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki).

Plasma turbulence and the diffusion across the magnetic field by two inhomogeneous plasma instabilities were investigated in the case of large oscillation amplitudes. The experiments were performed in a Q device. (M.O.W.)

33480 (CONF-670104–Pt.1, pp 137-43) CURRENT INSTABILITY IN THE POTASSIUM PLASMA. Buchelnikova, N. S.; Salimov, R. A.; Eidelman, Yu. I. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki).

The development of the K-plasma instability, the plasma turbulence and the diffusion across the magnetic field in the case of large oscillation amplitudes were investigated. The experiments were performed on the Q machine with R = 2 cm, L = 36 cm, by $n \sim 10^9$ to 10^{10} cm^{-3}, and H ~ 600 to 3000 gauss. (M.O.W.)

33481 (CONF-670104–Pt.1, pp 283-301) NON-CORRELATION OF ANOMALOUS TRANSPORT AND OSCILLATIONS IN A Q-DEVICE. Decker, John A. Jr. (Sperry Rand Research Center, Sudbury, Mass.).

The results are reported of an experimental investigation into the effects of a "minimum-B" magnetic field geometry on the spontaneous oscillations and "anomalous" cross-field plasma transport previously observed in the plasma of the "TOPSY" Q device with a uniform axial magnetic field. (M.O.W.)

33482 (NP–16818) NEUSTOICHIVOST' SIL'NO NEODNORODNOI PLAZMY. (Instability of Strongly Unstable Plasmas). Preprint 27. Buchel'nikova, N. S.; Salimov, R. A. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1966. 17p. (In Russian). Dep.

This is the continuation of an earlier study (Zh. Tekh. Fiz., 35: 72, (1965)) of strongly unstable plasmas. In such a plasma the Larmor ion radius is comparable with the size of the inhomogeneity. Experiments indicate that the oscillation frequency appears to be independent of the magnetic field and is inversely proportional to the half-width of the plasma column. The azimuthal phase velocity is identical for all harmonics and is close to the ionic sound velocity. Studies of plasma states at high amplitudes showed that they lead to strong turbulence. Modulation of high frequencies by the first harmonic frequency shows that such oscillations are concentrated within the region of the plasma bunch corresponding to the first harmonic. (JPRS)

33483 (ORO–2598-1) INSTABILITIES DUE TO ANISOTROPIC VELOCITY DISTRIBUTIONS. Progress Report, September 1, 1966–June 1, 1967. Harris, Edward G.; Eldridge, Owen C.; Sugihara, Ryo; Walters, Gary M. (Tennessee Univ., Knoxville). Contract AT(40-1)-2598. 3p. Dep. CFSTI.

Research on plasma instabilities is discussed under the following main topics: kinetic equations, magnetized plasmas, and processes involving photons. (M.O.W.)

33484 (UCID–15127) TRANSIENT DEVELOPMENT OF THE HOSE INSTABILITY. Briggs, Richard J. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 2, 1967. Contract W-7405-eng-48. 15p. Dep. CFSTI.

A method for determining the transient development of the hose instability of a tickled beam which allows easy generalization to see the effects of filtering the loop signals and tickling at frequencies other than optimum was presented. (M.O.W.)

33485 EFFECT OF TWO-DIMENSIONAL INHOMOGENEITY IN THE INITIAL PARAMETERS ON PLASMA INSTABILITY. Moiseev, S. S. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 136-8(Jan.-Feb. 1967). (In Russian).

An example of drift-temperature instability is considered. These occur in experimentally available plasmas which are characterized by density and temperature gradients. This problem is studied from the viewpoint of the dispersion relation for the two-dimensional initial inhomogeneities which cause changes in drift frequencies. It is shown that in cases where density and temperature gradients are non-collinear, then the instability range increases. The broadened instability range includes cases with positive and negative gradients. In case of the absence of one of the temperature gradients, the instability regime exists if the normal temperature gradients satisfy a certain inequality. It is also pointed out that such gradients lead to enhancement of instabilities in other situations such as thermal conduction along the lines of force of magnetic fields. (ATD)

33486 UNIVERSAL INSTABILITY OF A RESISTIVE PLASMA COLUMN. Woo, J. C.; Rose, D. J. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 19: 104-6(July 17, 1967).

A highly ionized two-fluid plasma column was studied. It was found that the growth rate of the modes driven by the equilibrium electric field decreases, and the more prevalent universal mode dominates. The analysis is based on a linearized two-fluid model with finite resistance due to the presence of some neutral particles, and the equations are written in cartesian slab geometry. (M.O.W.)

33487 INSTABILITY OF A PLASMA WITH FINITE ORBITS IN TOROIDAL SYSTEMS. Pogutse, O. P. Zh. Eksp. Teor. Fiz., 52: 1536-43(June 1967). (In Russian).

It is shown that a shift of the leading centers of plasma particles in a nonuniform magnetic field (finite orbits) may play a role which is equivalent to transverse viscosity of the ions. The effective viscosity of the finite orbits can significantly exceed the familiar collisionless magnetic viscosity of the ions. When this circumstance is taken into account it is found that an instability may develop in the plasma which has been termed finite-orbit instability. Its development requires a much lower collision frequency than that required for other known dissipative instabilities. (auth)

33488 COMPUTER STUDY OF NONLINEAR CROSS-FIELD INSTABILITY. Sato, Tetsuya; Tsuda, Takao (Kyoto Univ.). Phys. Fluids, 10: 1262-8(June 1967).

Evolution of a macroscopic cross-field instability in a weakly ionized plasma, first investigated by Simon on a linearized version, is studied numerically by solving a set of system equations. The dependent variables are replaced by spatial Fourier components. Calculations were carried out for two initial disturbances; i.e., a monochromatic disturbance and a white-noise-like disturbance. Results show that this instability explosively develops into a strong turbulence through wave–wave interactions between the excited Fourier modes. As far as the early stage of instability growth is concerned, it is found that machine calculations are in good agreement with linear analysis. (auth)

33489 TEST WAVES IN WEAKLY TURBULENT PLASMAS. Aamodt, R. E. (Boeing Scientific Research Labs., Seattle. Univ. of Texas, Austin). Phys. Fluids, 10: 1245-50(June 1967). (ORO–3458-2).

The basic ideas of weak turbulence theory are discussed, and the nonlinear theory of collisionless plasma dynamics is formulated in terms of test waves. The test-wave method is interpreted and compared to the usual mode coupling expansion technique. The smearing of the particle–wave resonances and the nonlinear coupling of unstable modes are discussed in detail. (auth)

33490 INSTABILITY AND MELTING OF THE ELECTRON SOLID. Van Horn, H. M. (Univ. of Rochester, N. Y.). Phys. Rev., 157: 342-9(May 10, 1967).

The electron solid, originally postulated by Wigner as the low-density limit of the hypothetical electron plasma, is shown to be unstable against breakdown of uniformity in the background charge distribution for $r_s > 6.4$, where r_s is the radius of the unit sphere in Bohr radii. The effects which arise when the background charge is lumped into homogeneous ion cores of fixed size are then considered, and it is shown that the differences in the correlation energies and equilibrium densities of the alkali metals can be qualitatively explained by this model. Since the melting "criteria" which have previously been applied to the electron solid are independent of the question of stability, the two principal criteria are next critically reviewed, and it is demonstrated that an improvement of the argument of de Wette leads to a predicted melting density which corresponds to $r_s \approx 27$. The improved melting condition is applied to solid hydrogen at zero temperature and is shown to agree quite closely with an explicit thermodynamic calculation of the melting point for this case. The predicted melting density is 4.5×10^6 g/cc. (auth)

33491 CYCLOTRON INSTABILITY OF MONOENERGETIC IONS IN A CURVILINEAR MAGNETIC FIELD. Mikhailovskaya, L. V. JETP Lett. (USSR) (Engl. Transl.), 5: 279-81(May 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 339-41(May 1, 1967).

It is shown that allowance for the curvature of the magnetic field leads to one more version of cyclotron instability in a plasma with monoenergetic ions. This instability develops near the ion cyclotron frequency and its harmonics and exists at parameters for which other types of cyclotron instability are impossible. (M.O.W.)

33492 STABILIZING EFFECT OF MODE COUPLING IN COLLISIONLESS PLASMA. Krall, Nicholas A. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Rev., 158: 138-43(June 5, 1967).

Plasma instabilities produce fluctuating electric and magnetic fields in a limited mode spectrum of frequency and wave number. It is shown that under many circumstances mode coupling can lead to a saturated wave spectrum which turns off the instability.

This process can take place in a time shorter than the time required for quasilinear relaxation of the plasma distribution function, and the saturated wave spectrum can be quite unrelated to linear growth characteristics. The low-frequency electromagnetic drift wave is given as an example. (auth)

33493 EXPONENTIAL STABILITY OF NONUNIFORM GUIDING CENTER PLASMA. Kadish, Abraham (New York Univ., New York). J. Math. Phys. (N. Y.), 8: 884-8(Apr. 1967).

Sufficient conditions are derived for the exponential stability of nonuniform collisionless guiding-center plasma when the magnetic field in equilibrium is unidirectional. These conditions are local analogs of the criteria obtained for uniform plasma equilibria. Growth rates slower than exponential ones are considered. (auth)

33494 STUDIES OF A TENUOUS CROSSED-FIELD PLASMA CONTAINED IN A MAGNETIC BOTTLE. Colchin, Richard Jennings. Columbus, Ohio, Ohio State Univ., 1966. 169p.

Thesis.

A plasma was formed in a cylindrical chamber 10 cm in diameter. The pressure in the chamber was maintained at 10^{-4} mm Hg by an automatically controlled gas leak system. A wire on the axis was held at voltages in the vicinity of –700 V. A magnetic field of the "bottle" or mirror shape was impressed in the longitudinal direction. Typical magnetic fields were of the order of 50 to 200 gauss. The distance between the magnetic mirrors was 31.5 cm. Ion currents in the neighborhood of 100 μA were collected by the center wire. Only a small number of electrons reached the outer chamber walls. Most electrons were lost through the magnetic mirrors, the greater number at radii near the outside of the plasma. A relatively small number of ions were lost at the ends. Langmuir probe studies at the plasma center could be made only in the region r = 3.0 to 2.0 cm because of low plasma density at larger radii and interference with the plasma at smaller distances. Typical measured electron temperatures were 70 eV and densities were in the range of 10^7 to 10^8 electrons/cm^3, the density falling off rapidly with radius. Under the above conditions of electric field, magnetic field, and pressure, two distinct instability forms appeared. The first had a helical shape, twisting with axial distance while rotating azimuthally. This instability was observed as either one, two, or three helices rotating simultaneously. They were called m = 1, m = 2, and m = 3 modes. Their frequencies were $f_1 = 10^5$/sec, $f_2 = 2.5 \times 10^4$/sec, and $f_3 = 1.4 \times 10^4$/sec, respectively. There was also evidence of a possible m = 4 oscillation with $f_4 = 5 \times 10^3$/sec. These modes were distinct, different modes appearing at different magnetic field strengths for fixed pressure and center wire voltage. They appeared only under conditions in which the plasma was relatively weak. The second instability form did not twist with length. It had a rotational frequency of $f = 6 \times 10^3$/sec, the frequency increasing with magnitude of the center wire potential. Near turnon this oscillation decayed away periodically, electrons escaping at the mirrors with each decay. For higher density plasmas this decay disappeared, the resulting steady oscillations being the dominant mode in relatively stronger plasmas. (Disser. Abstr.)

Shielding

33495 (EUR-3472.d) DIE BERECHNUNG ORTSABHAENGIGER NEUTRONENSPEKTREN IN WASSER-EISEN-WASSER-SCHILD-ANORDNUNGEN UND DIE BEZIEHUNGEN DER DIFFUSIONSNAEHERUNG ZUR EXAKTEN TRANSPORTTHEORIE IN GEBIETEN STARKER FLUSSGRADIENTEN. (The Calculation of Place-Dependent Neutron Spectra in Water–Iron–Water Shielding Assemblies and the Relations of the Diffusion Approximation for Exact Transport Theory in High-Flux-Gradient Areas). Fiebig, R. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht (West Germany)). May 1967. 118p. (In German). Dep.

The pattern of the neutron spectra in a plane water/iron/water shielding assembly was calculated with a BINE neutron-transport program and from the results, group constants for a multi-group diffusion calculation were derived. In addition to the neutron-flux and flow pattern, the place dependence of the group constants was studied and significant differences were recorded compared with the P1 approximation of the group constants obtained. The transport results were checked by means of group constants averaged according to areas, and the results are discussed. (auth)

33496 (JINR-P9-3365) IZMERENIYA DOZNOGO POLYA SMESHANNOGO IZLUCHENIYA ZA STAL'NOI ZASHCHITOI. (Measurement of a Dose Field of Mixed Radiation Behind the Steel Shielding). Zel'chinskii, M.; Komochkov, M. M.; Sychev, B. S.; Cherevatenko, A. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 8p. (In Russian). Dep.

The dose rate, the quality factor and the neutron fluxes of different energy groups behind the shielding, exposed to 660 MeV proton beam, have been measured. The relation between the >20 MeV neutron flux density and the dose rate of all the components of radiation is obtained to be 10 n/cm^2 μrem. The quality factor of mixed radiation behind the shielding is equal to 6.2 ± 0.4. (auth)

33497 (ORNL-RSIC-17) COMPARISONS OF RESULTS OBTAINED WITH SEVERAL PROTON PENETRATION CODES. Scott, W. Wayne; Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.). July 1967. Contract W-7405-eng-26. 27p. Dep. CFSTI.

Comparisons of the results obtained for a hypothetical problem with four different proton penetration codes included in the Radiation Shielding Information Center's code collection are presented. All the codes include secondary-particle production and transport in some approximation. The hypothetical problem was to find the dose as a function of depth in tissue resulting from a typical solar-flare proton spectrum normally incident on an infinite slab shield which is followed by the slab of tissue. The tissue was assumed to be 30 g/cm^2 thick. The solar proton spectrum was taken to be exponential in rigidity with a characteristic rigidity, P_0, of 100 MV and was normalized to 10^9 protons/cm^2 with energy >30 MeV. Graphs comparing both the total and the various secondary-particle contributions to the dose for aluminum and iron shields are presented. Definite inconsistencies between some of the codes are apparent. (auth)

33498 (ORNL-RSIC-18) ESTIMATES OF PRIMARY AND SECONDARY PARTICLE DOSES BEHIND ALUMINUM AND POLYETHYLENE SLABS DUE TO INCIDENT SOLAR-FLARE AND VAN ALLEN BELT PROTONS. Scott, W. Wayne (Oak Ridge National Lab., Tenn.). July 1967. 25p. Dep. CFSTI.

Primary proton and secondary particle doses (both physical and biological) behind aluminum and polyethylene slabs of varying thicknesses have been computed for normally incident solar-flare protons with spectra of characteristic rigidities (P_0 = 50, 60, 80, 100, 120, and 195 MV) and for the Freden–White spectrum of protons in the Van Allen belt. The computations were performed with a proton penetration code (CCC-64/LPSC) recently developed by the NASA Lewis Research Center. (auth)

33499 (ORNL-TM-1839) HIGH-ENERGY NUCLEON TRANSPORT. Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.). June 6, 1967. Contract W-7405-eng-26. 32p. (CONF-670602-22). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

The recent work on the transport of high-energy nucleons through dense matter is reviewed. The application of this transport to space-shielding studies is emphasized so the discussion is restricted to low and intermediate energies (≤1 GeV) and to relatively thin shields. (auth)

33500 (R-OU-246) INITIAL RADIATION SPECTRA DEFINITION. Final Report. Bryan, F. A. Jr.; Wright, M. D.; Nicholls, A. B.; Benjamin, A. J.; Wright, J. C. (Research Triangle Inst., Durham, N. C. Operations Research and Economics Div.). May 1967. Contract DA-49-146-XZ-499. 72p. (DASA-1934).

Calculations were performed to determine the initial gamma radiation spectra from nuclear weapons as a function of weapon–shelter distance. The purpose of these calculations was to determine standard gamma spectra which could be used in initial weapon radiation shielding calculations. The calculations are described by which the initial radiation spectra were determined. The sources of photons that were considered in the calculations included prompt fission gammas, early fission product gammas, and gammas due to radiative neutron capture by air nitrogen. It is shown that the differential energy spectra associated with each of the photons sources obtain a pseudo-equilibrium in their scattered components. These pseudo-equilibria obtain after photon penetrations in air of 1.0 to 1.5 miles. It is recommended that the one-mile distributions, as defined by the calculations, be used as standards for initial radiation shielding calculations. (auth)

33501 (UJV-1755) VYPOCET TOKU γ-ZARENI INTENZITY DAVKY A TEPELNEHO ZDROJE VE STINENI JADERNEHO REAKTORU. (Calculation of Gamma Dose Rates and Gamma Heat Source in Shielding of Nuclear Reactor). Rataj, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Feb. 1967. 17p. (In Czech). Dep.

A multigroup gamma attenuation code designed for computing gamma heating and gamma dose in the multiregion finite cylindrical or slab shield is described. The buildup factor method is used. The buildup factor can be chosen for water, iron, or aluminum. The appropriate analytical solution for uncollided flux is then used with the Taylor form of the buildup factor. The thermal and epithermal neutron fluxes in core, reflector, and

shielding regions are approximated as the sum of two exponential functions. In the core three kinds of gamma sources are considered: prompt gamma rays, gamma rays emitted by steady-state fission products, and capture gamma rays. In the other regions only the neutron capture is considered. A calculation program for the computer GIER in the ALGOL language is described and a sample calculation is included. (auth)

33502 (AEC-tr-6719, pp 1-6) NEUTRON DOSE COMPOSITION IN SHIELDING MATERIALS. Kramer-Ageev, E. A.; Mashkovich, V. P.; Sakharov, V. K. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

Calculations were made of dose distributions in water, carbon, beryllium, concrete, and iron for the limiting energies of 0.5, 1.0, and 1.5 MeV between the intermediate and fast neutron groups. The results were compared with earlier data. An estimation of the accuracy of the conventional fast-neutron detectors was made. (M.O.W.)

33503 (AEC-tr-6719, pp 19-22) INTERFACIAL ENERGY DISTRIBUTION OF NEUTRONS. Dvukhsherstnov, V. G.; Dulin, V. A. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

Measurements were made of water-environmental interfacial energy distributions of neutrons from a point source of fast neutrons with a mean energy of 3.25 MeV. The following shielding materials were investigated: water (12 cm), graphite (20 cm), aluminum (10 cm), iron (10 and 15 cm), nickel (6 and 12 cm), and lead (12 cm). The measurements were made in barrier geometry: the detector was set at the environment–water interface at the point where the normal through the neutron source met the interface. (M.O.W.)

33504 (AEC-tr-6719, pp 23-8) SOLUTION OF NEUTRON AGE EQUATION FOR A PLANE COSINE-LAW SOURCE. Anokhin, Yu. A.; Kimel', L. R. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

A solution was derived for the neutron age equation for a plane cosine source. This solution is applied to determine the buildup of intermediate neutrons. (M.O.W.)

33505 (AEC-tr-6719, pp 71-2) REFLECTION OF GAMMA-RADIATION EMERGING FROM A SEMI-INFINITE ACTIVE WATER MEDIUM BY AIR. Pavlov, V. V. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

Approximate formulas are given for gamma–gamma currents and fluxes emerging from a semi-infinite source with uniformly distributed activity. (M.O.W.)

33506 (AEC-tr-6719, pp 74-6) ANGULAR ENERGY DISTRIBUTION OF GAMMA RADIATION FROM A SEMI-INFINITE MEDIUM WITH UNIFORMLY DISTRIBUTED ISOTROPIC SOURCES. Pavlov, V. V. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

It is pointed out why an approximate relation previously developed by the author for the angular energy distribution of γ radiation emerging from a semi-infinite medium is inaccurate. An alternative solution is then used to determine the energy flux in water. (M.O.W.)

33507 (AEC-tr-6719, pp 77-8) SPECTRAL-ANGULAR DISTRIBUTION OF RADIATION FROM THE LATERAL WALLS OF A CHANNEL IN SHIELDING. Panchenko, A. M. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

The spectral angular distribution of scattered radiation from a plane unidirectional source in iron was derived using the model of a point unidirectional source. The theoretical results were applied to calculate the spectral-energy distributions of stray radiation emerging from lateral walls of channels. (M.O.W.)

33508 (AEC-tr-6719, pp 80-9) SOME EXPERIMENTAL RESULTS CONCERNING THE SHIELDING PROPERTIES OF MATERIALS IN RELATION TO HIGH-ENERGY PROTONS. Afanas'ev, V. P.; Biskupchuk, A. M.; Dudkin, V. E.; Kovalev, E. E.; Kuznetsov, V. G.; Litvinouva, E. G.; Smirennyi, L. N. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

Experimental results are presented on high-energy proton dose attenuation in various shields. The experimental data are compared with theoretical findings. (M.O.W.)

33509 (NASA-TT-F-411) PROBLEMS IN REACTOR SHIELDING PHYSICS. Collection of Articles. Broder, D. L.; Veselkin, A. P.; Egorov, Yu. A.; Orlov, V. V.; Tsypin, S. G. (eds.). Translation of Voprosy Fiziki Zashchity Reaktorov. Sbornik Statei, Gosatomizdat, Moscow, 1963. 522p. CFSTI.

Original in NSA, 18: 9586.

Articles are presented which are concerned with the experimental and theoretical investigation of the biological shielding of nuclear reactors as well as works on the methodology and instruments for studying the shielding. The articles consider different analytical methods which make it possible to determine the three-dimensional energy and angular distribution of radiations in the shielding, the results of many experiments with radiations penetrating through homogeneous and multilayer shielding, penetration through shielding with heterogeneities, etc. Device used to determine fluxes and spectral radiation distribution beyond and inside the shielding are described. (M.O.W.)

33510 CALORIMETRIC MEASUREMENT OF THE ACTIVITY, ABSORBED DOSES AND BUILDUP FACTORS OF INTENSE γ SOURCES. Picq, Michel. Ann. Phys.(Paris), 2: 17-25(1967). (In French).

A calorimetric method was set up whereby the weak energy losses of gamma radiation were measured through a screen by measuring the emitted quantity of heat. This method makes it possible to determine the value of the self-absorption and the absolute intensity of the sources, i.e., the number of primary photons emitted within the radioactive sample. With the experimental conditions — large self-absorption and large thickness of the screens — the radiation is subject to a large number of scattering and degradation in the sources and the screens. A representation of the results is proposed in terms of a build-up of the absorbed energy, i.e., the ratio of the integral absorbed dose which was measured directly and the energy yielded by the primary photons. ^{198}Au and ^{60}Co sources and the absorption of their gamma radiation in gold, nickel and graphite were studied in this fashion. (auth)

33511 BACKSCATTERING OF γ RAYS FROM Al BARRIERS. Pozdneev, D. B.; Churin, S. A.; Gokhshtein, L. E. At. Energ. (USSR), 22: 285-90(Apr. 1967). (In Russian).

Albedo for Al barriers of thicknesses up to 2 photon path lengths were calculated by the Monte Carlo method. Energies of 0.3, 0.5, and 1.0 MeV and incident angles of the monodirectional γ force (relative to the normal to the barrier) of 0, 30, 45, 60, 75, and 85° were investigated. From analysis of the data the empirical formula for calculation of the albedo from the barrier of finite thickness $A_x = A_\infty(1-e^{-Ax})$ is proposed. Data on the dependence of A_∞ (albedo semi-infinite media) and A (empirical magnitude) on the energy of the primary photon E_0 and the incident angle θ_0 were given. The results of the calculation agree well with the data obtained by the method of statistical analysis and experiments. (tr-auth)

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Refer also to abstract 33349.

33512 (AD-634445) PHONON CASCADE THEORY. Smith, E. F.; Landsberg, P. T. (University Coll. of South Wales and Monmouthshire, Cardiff). Nov. 1965. Contract AF61(052)-664. 52p. (AFCRL-66-222). CFSTI.

A generalized formulation is given of the Lax electron cascade capture model. An electron capture cross section is obtained, via an essentially classical argument, in terms of quantum mechanical transition probabilities, which may include various suitable electron–boson interactions. The electronic potential energy, in the presence of an impurity center, was assumed to behave as to the 9th power. Cross sections were obtained for the electron–acoustic and optical phonon interactions. In the latter case cross sections were obtained for both neutral (n = 4) and Coulomb attractive centers (n = 1), in germanium and silicon, the sticking probabilities being taken from previous literature. When comparable with earlier work, the cross sections obtained are smaller (by at most a factor of 10). New estimates include cross sections for electron capture by neutral centers in silicon, with optical phonon emission, over a range of temperatures. (auth) (TAB)

33513 (AERE-R-5478) FMLS: A FULL-MATRIX LEAST SQUARES PROGRAM FOR CRYSTAL STRUCTURE REFINEMENT. Bracher, B. H.; Taylor, R. I. (Atomic Energy Research Establishment, Harwell (England)). May 1967. 62p. Dep. CFSTI. UK 8s.

A FORTRAN computer program for use with x-ray or neutron data is described. The program is one of a series for structure determination with compatible input and output. Details of the use of the program, a program listing, and a glossary are given. The use of a second program, TAPEDIT, for handling reflection data on magnetic tape for input to FMLS, is described in an appendix. Program decks are available from the authors. (auth)

33514 (COO-1054-31) ELECTRON PARAMAGNETIC RESONANCE ABSORPTION STUDIES OF (Al_2O_3)/sub 1-x/ (Cr_2O_3)/sub x/ WITH CONTROLLED NEUTRON TREATMENTS. Wenzel, Richard Fredrick William (Wayne State Univ.,

Detroit, Mich.). 1966. Contract AT(11-1)-1054. 77p. Dep. CFSTI.

Thesis.

Single-crystal samples of $(Al_2O_3)_{1-x}(Cr_2O_3)_x$ with x = 0.01% and 0.001% were irradiated with fast neutrons for dosages between 10^{18} and 10^{19} nvt near room temperature. The EPR absorption studies of the irradiated samples yielded two major points of interest: First, the linewidth after irradiation depends not only on the polar angle θ but also on the azimuthal angle ϕ, while it depends only on θ before irradiation. For a given set of values of θ and ϕ, the linewidth after irradiation is substantially larger than that before irradiation. Secondly, the irradiation causes the center of resonance of the individual lines to shift slightly (0.2% at most) relative to that of the corresponding lines before irradiation. The observed results were examined in terms of two alternative models, the strain-source model and the charge-source model, which describe the effect of irradiation on the Cr^{3+} sites in terms of a random Gaussian distribution of radiation-induced strains and radiation-induced static electric fields, respectively. The strain-source model yields a satisfactory fit to the observed anisotropy of the linewidth and is consistent with the observed shift in the resonant magnetic field. The charge-source model yields a less satisfactory fit to the observed anisotropy of the linewidth. In addition, it fails to predict the shift in the resonant magnetic field. The optimum rms values of the strains are as follows: $\Delta\epsilon_1 = \Delta\epsilon_2 = \Delta\epsilon_3 = \Delta\epsilon_4 = \Delta\epsilon_5 = \Delta\epsilon_6/\sqrt{2} = 1.8 \times 10^{-4}$. (auth)

33515 (COO-1488-4) TIME CORRELATIONS OF SPIN OPERATORS IN FINITE LINEAR MAGNETIC CHAINS. Carboni, Fernando (Kansas Univ., Lawrence. Dept. of Physics). Mar. 1967. Contract AT(11-1)-1488. 169p. Dep. CFSTI.

Thesis.

A numerical study of time correlations of spin operators and resonance linewidth for finite antiferromagnetic chains of spins $\frac{1}{2}$ coupled by isotropic exchange (Heisenberg) interaction is reported. A general method for diagonalization of the isotropic-exchange Hamiltonian matrix is presented. Matrices are diagonalized for chains of 4 to 11 spins. The correlation functions are studied as functions of the frequency, temperature, and number of spins. The correlation functions are used to compute the frequency dependence of the resonance linewidth for copper tetrammine sulfate monohydrate. It is found that the frequency dependence of the resonance linewidth predicted by using the exact correlations gives a better agreement with experiment than that predicted on the basis of the gaussian approximation. However, the observed value of the linewidth is about twice the value found in calculations considering dipolar interactions only. (A.G.W.)

33516 (COO-1533-6) STUDY OF INTERACTIONS BETWEEN f-SHELL TRANSITION IONS IN NON-METALLIC CRYSTALS. Annual Technical Progress Report, October 1, 1966-June 15, 1967. Carlson, Edward H. (Michigan State Univ., East Lansing. Dept. of Physics). June 30, 1967. Contract AT(11-1)-1533. 8p. Dep. CFSTI.

The electrostatic, exchange, and magnetic dipole interactions between f-shell ions, particularly as manifested in the properties of magnetic ordered states (ferromagnetic and antiferromagnetic) arising from these interactions, were studied. Several rare earth halides ($PrCl_3$, $GdCl_3$, $ErCl_3$, $PrBr_3$, and DyF_3) were investigated using nuclear magnetic and quadrupole resonance techniques, and ac susceptibility. (W.D.M.)

33517 (ORO-2430-39) A STUDY OF SPIN-WAVE SPECTRA AND SURFACE EFFECTS IN THIN NICKEL FILMS DEPOSITED IN ULTRA-HIGH VACUUM. Chambers, William Forrest (Duke Univ., Durham, N. C. Dept. of Electrical Engineering). May 1967. Contract AT(40-1)-2430. 141p. Dep. CFSTI.

Multiple spin-wave resonances have been observed in thin nickel films deposited on glass substrates held at elevated temperatures. Shadowed-surface-replica and direct-transmission-electron micrographs of these films show that they have very rough surfaces; many surface bumps are nearly as high as the films are thick. It has been deduced from the surface measurements that the stress patterns in such films are very complex and that a dynamic pinning model yielding weak pinning through an internal stress field variation or through a surface-bump-caused variation in the internal-magnetic-field intensity will provide the most appropriate model for a theoretical analysis of spin-wave resonance in such films. Measurements of average grain size and surface-bump heights in the films indicate that the film formation mechanism proposed by Wilman is applicable to films deposited in ultrahigh vacuum. Hysteretic resonances that occur at applied magnetic field intensities of less than $4\pi M$ and an anomalous low power absorption by the first resonance mode are reported. The nickel films used varied in thickness from 50 to 5000 Å and were deposited by electron bombardment. The background pressures during deposition were varied from 1×10^{-7} to 4×10^{-10} torr while the substrate temperatures were varied from room temperature to 350°C. (auth)

33518 (SC-DC-66-2449) HALL EFFECT MEASUREMENTS IN SHOCK-LOADED SEMICONDUCTORS. Kennedy, J. D. (Sandia Corp., Albuquerque, N. Mex.). June 1967. Contract AT(29-1)-789. 18p. (CONF-670914-7). Dep. CFSTI.

From International Symposium on the Behavior of Dense Media Under High Impulsive Pressures, Paris, France.

Successful Hall effect measurements were performed before, during, and immediately after the passage of a plane shock wave through doped single crystal semiconductor specimens. A stress pulse having an amplitude slightly less than the Hugoniot elastic limit of the sample was produced by a low pressure explosive plane wave lens. Hall voltage measurements were made during the 5 μsec prior to shock wave entry and the 3 or 4 μsec during and immediately following shock propagation through the specimen. The sample was surrounded by carefully mated identical material which, for the duration of the experiment, ensured that the specimen was in a state of one-dimensional strain. A uniform magnetic field of up to 30 kG was produced in the sample by means of an expendable solenoid, and the Hall current was switched on just prior to shock wave entry into the semiconductor. The behavior of doped n- and p-type Si and Ge in the [100] crystallographic orientation was investigated. Particularly interesting results were obtained for p-type, gallium doped (100) Ge and n-type (100) Si having a carrier concentration of $\approx 10^{14}$ carriers/cm^3. Both these materials exhibited Hall voltage sign reversal under shock loading conditions. These and other results are presented and discussed. (auth)

33519 (UCRL-17479) I. RELAXATIONS IN A MOLECULAR CRYSTAL. II. THE FERMI MOMENTUM OF ALUMINUM FROM 0 TO 100 KILOBARS. Burton, James J. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1967. Contract W-7405-eng-48. 121p. Dep. CFSTI.

Thesis.

Properties of imperfect lattices of monatomic face-centered-cubic crystals are examined theoretically. The atomic interactions are represented by pair-wise additive potentials. The configuration of the atoms near each imperfection is obtained. The effects of relaxations on the energies of the defects are examined. For bulk defects (vacancies, divacancies, substitutional atoms, and substitutional-atom – vacancy pairs) the relaxations are small and only slightly alter the energy of the defect. Vacancies in argon are bound to other vacancies or to substitutional impurities. The activation energy, E, in the Arrhenius expression $D = D_0 e^{-E/RT}$ is calculated for self-diffusion in argon for both monovacancy and divacancy exchange diffusion. The results for monovacancy mechanism (E = 3812 cal) and the divacancy mechanism (E = 4847 cal) are both in reasonable agreement with the experimental diffusion coefficient $D = 15\ e^{-4120\ cal/RT}$. The frequency factor, D_0, for the divacancy mechanism is much greater than that for monovacancies. This indicates that the self-diffusion mechanism in solid argon at zero pressure may be via divacancies. The activation energies for neon and krypton impurity diffusion via monovacancy exchange are 2187 and 3733 cal, respectively. In all cases, the relaxations of surrounding atoms drastically lowered the barrier to diffusion. The relaxations and surface energies of (100), (111), and (110) surfaces of aluminum, argon, calcium, copper, lead, nickel, and silver are calculated. The relaxations of the surface are less than 15% of the bulk planar spacing. The relaxations only slightly alter the surface energies. The energies of adsorption of argon, krypton, and neon atoms on the (100) surface plane of argon are calculated. Relaxation appreciably affects the adsorption energies. The adsorption energies increase in the order neon, argon, krypton. The Fermi momentum of aluminum is studied from 0 to 100 kilobars pressure. Bridgman anvils were used to generate the pressure and the positron annihilation spectrum was studied at five pressures. The Fermi momenta are obtained from the positron annihilation spectra. The experimental values of the Fermi momenta of aluminum are in excellent agreement with the prediction of the free electron model: $p_F = \hbar(3\pi^2 Z/V)^{1/3}$, where Z is the number of conduction electrons per unit cell of the metal and V is the volume of the unit cell. (auth)

33520 ESR AND ENDOR OF GAMMA-IRRADIATED $AgNO_3$. Tagaya, Kimihito; Nogaito, Takeshi (Osaka Univ.). J. Phys. Soc. Jap., 23: 70-6(July 1967).

Two paramagnetic species produced in $AgNO_3$ by gamma irradiation at room temperature were identified to O_2^- and NO_2, and direction cosines of principal axes of these centers with respect to the crystal axes were determined. From these results, it was confirmed that both O_2^- and NO_2 were trapped with definite directions in the NO_3^- vacancies and their radical planes were nearly the same as those of NO_3^- ions, but the definite directions of these two radicals are different from each other. Moreover, super

hyperfine interactions of O_2^- with neighboring Ag nuclei were studied by ENDOR. (auth)

33521 OPTICAL STUDY OF VACANCY PROCESSES IN NaCl AT ROOM TEMPERATURE. Sanchez, C.; Agullo-Lopez, F. (Junta de Energia Nuclear, Madrid). Solid State Commun., 5: 495-8(1967).

The room-temperature kinetics for the trapping of free anion vacancies in NaCl, after a high-intensity γ irradiation, were determined by means of F-center analysis. It is found that the trapping process saturates in a time of about 60 min. (auth) (UK)

33522 PARAMAGNETIC RESONANCE OF THE Ag^{2+} ION IN IRRADIATED ALKALI CHLORIDES. Sierro, Jerome (Argonne National Lab., Ill.). J. Phys. Chem. Solids, 28: 417-22(Mar. 1967).

Paramagnetic resonance was studied for Ag in the $4d^9$ configuration substituting for alkali metal ions in alkali metal chlorides. The symmetry of the Ag^{2+} complexes is less than cubic because of the Jahn–Teller effect. Two spectra are observed, corresponding to the low- and high-temperature modifications of the same spectrum under a dynamical Jahn–Teller distortion. The data are fitted to an appropriate spin Hamiltonian, and the temperature dependence of the spectra is discussed. (auth) (UK)

33523 FERROELECTRIC BEHAVIOR OF RADIATION-DAMAGED TRIGLYCINE SULFATE AND ROCHELLE SALT UP TO HIGH DOSAGE. Okada, K.; Gonzalo, J. A.; Rivera, J. M. (Puerto Rico Nuclear Center, Mayaguez). J. Phys. Chem. Solids, 28: 689-95(Apr. 1967).

An experimental study of the effects of ionizing radiation on the ferroelectric behavior of triglycine sulfate and Rochelle salt was carried out. The investigation was extended up to relatively high doses, in order to ascertain whether the reported drastic decreases and disappearance of the hysteresis loops and the well known blurring of the peak in the dielectric constant vs temperature curve were related to the destruction of ferroelectricity itself in the crystal or, rather, to the progressive masking of ferroelectric characteristics by the presence of a large accumulation of radiation-induced defects in an essentially ferroelectric environment. Experiments included measurements of the temperature dependence of hysteresis loops and dielectric constant at increasing values of the irradiation dose, under zero and variable dc fields. It was found that the ferroelectric characteristics remain well defined up to doses as high as 10 MRAD for triglycine sulfate. Similar results were obtained for Rochelle salt. In the latter case, however, the ferroelectric characteristics of the crystal disappeared at about 2 MRAD, as a consequence of the collapse of both Curie points. The changes in domain structure of Rochelle salt were also investigated using the polarizing microscope and an interpretation consistent with the results of the dielectric observations is given. (auth) (UK)

33524 MAGNETIC STRUCTURES OF HOLMIUM. II. THE MAGNETIZATION PROCESS. Koehler, W. C.; Cable, J. W.; Child, H. R.; Wilkinson, M. K.; Wollan, E. O. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 158: 450-61(June 10, 1967). (ORNL-P-2820).

Neutron-diffraction measurements were made on single-crystal holmium at temperatures ranging from 4.2 to 120°K in applied magnetic fields up to 22.3 kOe in order to study the magnetization process of this material. At low temperatures, the b direction in the basal plane is an easy axis. For a field applied parallel to an a direction, the moments are aligned parallel to the closest b directions. At higher temperatures the effect of a field applied parallel to a b direction is to transform the system to a b-axis ferromagnet after causing it to pass through one or two (depending upon the temperature) intermediate fanlike oscillatory structures. Similar oscillatory configurations are produced by the application of a field parallel to an a direction. The a-axis ferromagnet is not produced in fields up to 22.3 kOe. A characterization of the four intermediate structures observed at 50°K was made and schematic phase diagrams in the H–T plane were extracted from the diffraction and magnetization data. Studies of the remanent state at 4.2°K were made, and are reported. (auth)

33525 IMPLANTATION OF IONS INTO CRYSTAL LATTICE. Perovic, Branislava (Boris Kidric Inst. for Nuclear Sciences, Belgrade). Nukl. Energ., 4: No. 1, 5-11(1967). (In Slovak).

Recent knowledge of the effects of interaction of keV ions with the crystal lattice during and after ion bombardment is reviewed. The first part reviews the characteristic parameters and processes accompanying the penetration of energetic ions into the crystal lattice, such as the efficiency of implantation, sputtering of the surface, the saturation phenomena, the range and depth distribution of ions incorporated into the lattice, the influence of the lattice regularity on the depth of ion penetration, the radiation damage of the lattice, etc. The second part reviews the post-irradiation phenomena in the targets bombarded, such as diffusion of incorporated gas components and gas precipitation, thermal stability of the targets, etc. The third part reviews the essential features of the method for making high-quality semiconductor junctions using ion implantation or dopping technique. (auth)

33526 ELECTRICAL CONDUCTIVITY OF γ-IRRADIATED 3-MP GLASS AND OF PHOTOIONIZED 3-MP–TMPD DURING WARMING FROM 4° AND 77°K. Wiseall, Barrie; Willard, John E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-32. J. Chem. Phys., 46: 4387-99(June 1, 1967). (COO-32-124).

The electrical conductivity of γ-irradiated 3-methylpentane (3-MP) glass has been studied as a function of γ dose, temperature, applied voltage, post-γ illumination, and the nature and concentration of additives. Three distinct populations of charge carriers are found in samples γ-irradiated at 77°K. The first, attributed to the combined mobility of weakly trapped electrons and positive charges, decays almost completely in 30 min in the dark at 77°K. It is reduced by 0.01 mole % of the electron scavenger CCl_4, but is not affected by 1 mole % of the positive hole trap 2-methylpentene-1 (2-MP-1). The second, attributed to trapped electrons, is revealed by current flow between 83° and 88°K during warmup. It is eliminated by infrared illumination at 77°K before warm up (which causes a burst of current), or by alkyl halides, and is increased by 2-MP-1. The 85°K peak is absent on warmup of γ-irradiated 3-MP containing biphenyl, but appears if electrons are liberated from the biphenylide ion by illumination with 4100-Å light prior to warmup. The third population of charge carriers becomes mobile above about 92°K, giving maximum current at about 102°K. It is not affected by alkyl halide additives, and must be ascribed to migration of positive and negative ions. Additives capable of forming larger ions of lower mobility lower this current peak and produce new peaks. The areas of the peaks at 85° and 102°K are proportional to the applied voltage over the range tested (4×10^2 to 8×10^4 V cm^{-1}). They increase linearly with dose below 1×10^{18} eV g^{-1} but more slowly at higher doses. Blocking electrodes reduce these peaks. Between about 88° and 92°K the warmup current of γ-irradiated 3-MP becomes negative, suggesting randomization by thermal agitation of radiation-produced charges oriented by the applied electric field at 77°K. The warmup current spectrum of 3-MP following γ irradiation at 4°K shows a peak at about 60°K in addition to the peaks observed for warmup from 77°K. When tetramethyl-p-phenylenediamine (TMPD) in 3-MP at 77°K is photoionized, the warmup current shows a peak centered at 108°K, which differs from the similar peak produced by γ irradiation in that it is reduced by the presence of alkyl halides. The effect is attributed to complexing of TMPD by the alkyl halide with resultant trapping of the photoionized electrons in close proximity to the positive ion. (auth)

33527 PHONON-FREE ABSORPTION AND EMISSION TRANSITIONS IN IRRADIATION-COLORED NaF CRYSTALS. Baumann, G. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 203: 464-79(1967). (In German).

In γ-irradiated NaF crystals at 5456, 5754, 5837, 6070, and 6146 Å zero-phonon lines are observed in absorption and emission. These resonance lines are accompanied by multiphonon absorption and emission bands with their spectral positions nearly mirror symmetric with respect to the zero-phonon line position. By excitation spectra higher excited states are detected. Uniaxial stress splitting of the lines 5754 and 6070 Å is studied in absorption and emission. The color centers associated with the lines are found to exhibit rhombic symmetry with rotation axes along ⟨110⟩ and ⟨100⟩ directions and monoclinic symmetry with a rotation axis along ⟨110⟩ direction. The transitions in both centers correspond to ⟨110⟩ dipoles. In the monoclinic center the transition between the ground and the second excited state seems to correspond to a ⟨112⟩ dipole. (auth)

33528 THE RESIDUAL ACTIVITY METHOD FOR DETERMINING CONCENTRATION DISTRIBUTION. Bruggeman, G.; Kant, A. (Army Materials Research Agency, Watertown, Mass.). Int. J. Appl. Radiat. Isotop., 18: 539-40(July 1967).

The distribution of a radioactive tracer element within a specimen is often more conveniently determined by removing successive layers and measuring the activity that remains rather than by collecting the material from each layer and determining its specific activity. Assuming collimated radiation and exponential absorption, an expression is given for the residual activity per unit area, $\underline{A}(l)$, after removal of layers totaling a thickness $\underline{l}$. The residual activity technique has been successfully applied to the determination of diffusion coefficients in metals where the form of distribution of a radioactive element may be assumed from solutions to the Fick equations. A generalization has been made, however, in which no assumption regarding distribution of the radio-

nuclide is required, and thus the specific activity can be calculated directly from the residual activity regardless of the distribution of the former. Still further generalizations may also be made, which would be particularly useful in determining the specific activity on either side of a planar interface between two homogeneous phases, as in the analysis of diffusion through a protective coating into an underlying material. Applications to grain boundary diffusion are discussed—also problems due to beta emitters (nonexponential absorption), and the fact that collimated radiation is seldom encountered in practice. (UK)

33529 FURTHER COMMENTS ON VACANCY AND INTERSTITIAL CLUSTERS IN NEUTRON-IRRADIATED NICKEL. Hesketh, R. V.; Norris, D. I. R. (Berkeley Nuclear Labs., Eng.). J. Appl. Phys., 38: 3033-4(June 1967).

Defect clusters in neutron-irradiated nickel are discussed and explanations are investigated. (M.O.W.)

33530 DESORPTION OF SURFACE ATOMS BY EMERGING HIGH-ENERGY ELECTRONS. Pollard, J. H.; Danforth, W. E. (Franklin Inst., Swarthmore, Pa.). Appl. Phys. Lett., 11: 9-11 (July 1, 1967).

High energy electrons penetrating a solid and emerging from a surface can remove surface atoms by Coulomb interaction with their nuclei. Observations of this desorption process were made on a (100) tungsten surface with an absorbed layer of thorium atoms of known coverage. Electrons of energy up to 2 MeV were used and the rate of removal of thorium atoms was calculated from the rate of change of work function of a collector surface. Measurements of desorption rate as a function of energy suggest a binding energy of 15 to 20 eV, in contrast to the 8 eV obtained from thermal desorption. (auth)

33531 TRANSPORT PROPERTIES OF SEMI-INSULATING CdTe USING NUCLEAR PARTICLES. Zanio, K.; Akutagawa, W.; Mayer, J. W. (Hughes Research Labs., Malibu, Calif.). Appl. Phys. Lett., 11: 5-7(July 1, 1967).

The transient response of semi-insulating CdTe to monoenergetic alpha particles is composed of a fast component, characteristic of trapping, and slow component displaying the release of carriers from traps. It is verified that the shape of the fast component is directly proportional to $[1 - \exp(-t/\tau^+)]$ for electrons where τ^+ is the mean free drift time. From an analysis of the shape, τ^+ for electrons ranges from 30 to 90 nsec; mobilities from 600 to 1100 cm^2/V-sec. On a single-level model thermal and optical excitation data indicate a trapping level at 0.6 ± 0.05 eV from the conduction band. (auth)

33532 AN EXPERIMENTAL STUDY OF THE DIFFUSE X-RAY SCATTERING FROM SODIUM CHLORIDE. Eldridge, J. E.; Lomer, T. R. (Univ. of Birmingham, Eng.). Proc. Phys. Soc. (London), 91: 459-65(June 1967).

The diffuse x-ray scattering from sodium chloride single crystals was measured in nonsymmetry directions over a range of scattering angles from 20° to 110°. The measured intensities show that no need exists to consider defect diffuse scattering and that excellent agreement is obtained with the calculated intensities, using theoretical values of Compton scattering and computed values of thermal diffuse scattering. The first-order, second-order, and total values of thermal diffuse scattering were computed from the eigenvectors and eigenfrequencies of Karo and Hardy [Phys. Rev., 129: 2024-36(1963)]. Another approximate method of calculating the higher orders of thermal diffuse scattering intensity, involving only the Debye–Waller factors, is included. (auth) (UK)

33533 ISOTOPE TRANSPORT ALONG A TEMPERATURE GRADIENT IN Li METAL. Thernquist, P.; Lodding, A. (Chalmers Univ. of Technology, Goteborg). Z. Naturforsch., 22a: 837-9(May 1967).

It was found that, when a temperature gradient is maintained along a Li metal rod, the light isotope becomes enriched in the hot portion. It is inferred that isotope thermotransport and bulk thermotransport are governed by two different mechanisms. The isotope factor is of the order $a \approx +0.35$. (M.O.W.)

33534 EFFECT OF IRRADIATION TEMPERATURE ON THE SCATTERING OF LONG WAVELENGTH NEUTRONS BY DEFECTS IN NEUTRON-IRRADIATED GRAPHITE. Martin, D. G.; Henson, R. W. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon, 5: 313-6(June 1967). (AERE-M-1805).

Earlier work was extended by measurement of the scattering from graphite irradiated at 30, 200, and 450°C, and of the corresponding lattice parameter changes. The results are interpreted in terms of the scattering contribution from vacancies and from interstitial defects. It is concluded that the small interstitial clusters which are formed as a result of neutron irradiation are stable over a wide range of irradiation and annealing temperatures. (auth) (UK)

33535 RUTHERFORD SCATTERING OF PROTONS IN THE SURFACE LAYERS OF A TUNGSTEN SINGLE CRYSTAL. Boegh, E. (Univ. of Aarhus, Denmark). Phys. Rev. Lett., 19: 61-3 (July 10, 1967).

Rutherford scattering yields in a tungsten single crystal were used to obtain information about the motion of fast protons through the single crystal. A magnetic spectrograph was used in the energy analysis of the scattered protons. (TSS)

33536 INTERSTITIAL REMOVAL IN STAGE-III RECOVERY OF NEUTRON-IRRADIATED W. Attardo, M. J.; Galligan, J. M.; Chow, J. G. Y. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 19: 73-4(July 10, 1967). (BNL-11375).

Stage-III recovery in neutron-irradiated tungsten was observed to be an intrinsic recovery stage in which the removal of a self-interstitial-type defect occurred. The main sinks for these defects are the irradiation-produced single vacancies. (TSS)

33537 PARAMAGNETIC SUSCEPTIBILITY IN THE V_3Si TYPE OF COMPOUNDS IN THE NORMAL STATE. Labbe, J. (CNRS, Orsay, France. Univ., Paris, Orsay, France). Phys. Rev., 158: 647-54(June 15, 1967).

Tight-binding calculations, applied to a linear-chain model, give a rough description of the d-band structure of the V_3Si type of compounds, with very high peaks in the density of states. The Fermi level should fall in one of these peaks. This leads to a large and strongly temperature-dependent Pauli susceptibility. The orbital Van Vleck susceptibility is discussed with respect to the position of of the Fermi level in the d band. (auth)

33538 ^{51}V KNIGHT SHIFT IN THE V_3Si TYPE OF COMPOUNDS IN THE NORMAL STATE. Labbe, J. (Univ., Paris, Orsay, France). Phys. Rev., 158: 655-7(June 15, 1967).

Gossard has observed in V_3Si the effect on the ^{51}V Knight shift of the low-temperature structural transformation discovered by Batterman and Farrett. This effect can be explained in a simple model which assumes a fine d-band structure close to the Fermi level. This model has already given a fairly good explanation of the low-temperature lattice instability in the normal state. (auth)

33539 LOCAL ATOMIC ARRANGEMENTS STUDIED BY X-RAY DIFFRACTION. Proceedings of a Symposium held in Chicago, Illinois, February 15, 1965. Cohen, J. B.; Hilliard, J. E. (eds.). Met. Soc. Conf., 36: 1-381(1966). (CONF-650203).

Papers and discussions are included which review the quantitative measurement and interpretation of x-ray diffuse scattering. Emphasis is placed on the advances made during the last decade. The papers are arranged into two groups dealing with heterogeneities and line broadening, respectively. (D.L.C.)

33540 PROTON BOMBARDMENT OF HIGH-PURITY SILICON. Robertson, James Bratton. Blacksburg, Va., Virginia Polytechnic Inst., 1966. 47p.

Thesis.

High-purity single-crystal silicon was bombarded with 22-MeV protons, and the resulting damage was studied by infrared absorption and resistivity measurements. The integrated proton flux received by the crystals ranged from 7.5×10^{15} to 9.2×10^{16} protons/cm^2. The temperature of the silicon crystals during bombardment was <93°C for some samples and 400° to 1000°C for others. ^{27}Al was produced in the silicon crystals during the proton bombardment presumably by a $^{28}Si(p,2p)^{27}Al$ reaction. The $^{30}Si(p,2p)^{29}Al$ reaction was evidenced by observation of the 1.28-MeV γ from the $^{29}Al \xrightarrow{\gamma,\beta^-} {}^{29}Si$ decay. The ^{27}Al in the crystals was identified by the substitutional aluminum, Al_s, absorption spectrum. The production rate of ^{27}Al in a thick silicon target was 6×10^{-3} atoms/proton. The crystals which were irradiated at high temperature all had absorption peaks at 18.9, 21.1, and 22.0μ and increased p-type conductivity. These absorption lines are similar in both energy and structure to the Al_s absorption spectrum. The 18.9, 21.1, and 22.0μ lines differ in energy from their corresponding Al_s lines by +2.6, +0.6 and +2.5%, respectively. The absorption lines remained after anneals at temperatures up to and including 600°C. The lines were destroyed by an anneal at 1000°C, during which the Al_s spectrum appeared. It is concluded that the impurity responsible for the absorption and the conductivity is a substitutional aluminum atom plus a closely associated defect. The defect is concluded to be a vacancy cluster of three or more vacancies, which is definite in size and has a definite association with the aluminum. Arguments for the proposed model are based on the appearance of the absorption spectra, the energy shifts and the annealing data. The silicon crystals which were irradiated at the lower temperature had absorption peaks at 1.8, 5.5, 3.46, 3.62, and 20.5μ. An anneal of one of these crystals at 300°C produced absorption bands

with main peaks at 8.9 and 14.2μ. These two absorptions have not been previously reported. The 14.2μ line showed a strong temperature dependence, the 8.9μ line did not. Heating at 600°C annealed out both bands. Mention is made of the $(Al_i^- + Al_i^{2+})^+$ defect which is reported by Watkins because of the similarity in the conditions of productions and annealing for it and the 8.9μ and 14.2μ bands. (Disser. Abstr.)

33541 LITHIUM FLUORIDE THERMOLUMINESCENT RESPONSES TO NEUTRONS. Weng, Pao-shan. College Station, Tex., Texas A and M Univ., 1966. 94p.

Thesis.

Neutron-irradiated Con-Rad type-N and type-7 lithium fluoride are systematically studied according to the isothermal annealing, the glow curve analysis, and to the different energies ranging from thermal to 14 MeV. Special efforts have been made to investigate the half-life of isothermal decay, the kinetics, the frequency factor, the trap depth, the probability factor, and the dosimetry prospect. The details of neutron-flux measurements are given. Comparison of the thermoluminescent effect due to gamma rays and neutrons is also included. (Disser. Abstr.)

33542 OCCURRENCE OF NEW COLOR CENTER ABSORPTIONS IN POTASSIUM CHLORIDE. Ring, James George. Chicago, Illinois Inst. of Tech., 1966. 99p.

Thesis.

Three new, stable color center absorptions, designated as "T bands," have been identified in both additively colored and Co-60 γ-irradiated KCl. The wavelength maxima at 80°K are: 839 mμ (T_1), 894 mμ (T_2) and 992 mμ (T_3). The T bands were produced in samples containing ~10^{17} F centers per cm^3 by irradiating first with white light at 25°C to form M, R and N centers and then with narrow band "F light," "M light," "N light" or combinations thereof at 100°C. A comparison of the optical and thermal properties of the T bands with those of known color centers shows that the T bands arise from new and distinct F-aggregate centers and are not absorptions of the F, M, R or N centers. Light absorbed in either the T_2 or T_3 bands at 80°K induces temporary interconversions between T_2 and T_3 centers. The T_1 band is relatively stable against optical bleaching. The kinetics of interconversion were investigated both by pulse-irradiation techniques and by measuring transmission changes during steady irradiation. The results indicate that the optical interconversions occur by first-order processes with rate constants that are linear in the light intensity, and that there are dark processes in both directions. The T_2-to-T_3 dark conversion has a thermal activation energy of 0.12 eV between 40°C and −73°C. However, extrapolation of the data to 80°K gives a rate constant that is two orders of magnitude smaller than was observed, indicating that a second dark process is dominant at 80°K. A kinetic model is proposed in which the principal steps are: (a) photoionization of T_2 and T_3 centers and subsequent electron recapture at T_2^+ and T_3^+ centers, (b) unimolecular dark interconversions between T_2 and T_3 centers, and (c) a fast equilibrium between the T_2^+ and T_3^+ centers. Rate equations based on these processes are derived and solved for the absorption changes induced by optical bleaching. Both the transient and steady state solutions agree with the data. However, the descriptive features of this model are not unique to the kinetics. A conversion mechanism based on photo-excitation of T_2 and T_3 centers and a fast equilibrium between the excited states leads to equivalent kinetic equations which fit the data. In either case it is necessary to assume that the initial bleaching products of the T_2 and T_3 centers undergo rapid interconversion, which indicates that a simple structural relation exists between the T_2 and T_3 centers. (Disser. Abstr.)

33543 FAST ELECTRON DAMAGE AND ANNEALING IN P-TYPE GERMANIUM. Flanagan, Terry Michael. Lafayette, Ind., Purdue Univ., 1966. 140p.

Thesis.

Defects introduced by fast electrons at 10°K and 0°C in p-type germanium were studied using Hall coefficient and electrical conductivity measurements. Referring measurements to 30°K allowed nondegenerate material to be used, avoiding difficulties previously encountered in sensitivity and interpretation with degenerate material. All observed changes in the electrical properties, brought about by heating the lattice following irradiation, have occurred at temperatures higher than 30°K, and the use of electronic circuitry for temperature control made measurements at 30°K feasible. Lattice defects are produced in p-type germanium at 10°K by 1.0-MeV electrons, although the defects cannot be detected electrically immediately after bombardment. The defects are revealed in the form of ionized donors by illumination with light of energy less than the band gap. The ionization process causes a decrease in carrier concentration during illumination, which proceeds as $Ae^{-t/\tau_1} + Be^{-t/\tau_2}$, where $\tau_2 \approx 6\tau_1$. Following illumination, isochronal annealing and studies using constant warming rates show two recovery stages between 40°K and 70°K. The recovery stages are intimately connected with the time constants of the illumination decay. The extent of recovery in the low-temperature stage, centered at 52°K, depends on the degree of completion of the short-time constant decay, while the second recovery stage at 65°K is associated with the degree of completion of the long-time constant decay. Both recovery stages are found to be independent of the kind of chemical impurity used to dope the samples. Upon completion of the 40°K to 70°K thermal recovery, it is found that the electrical conductivity and the carrier concentration of the samples have returned to their prebombardment values. There are still defects present, however, for on further heating to 150°K a configuration known as the "two-state defect" is formed. This is the same defect that is observed following irradiation at 77°K. For material irradiated at 10°K, the transformation involved in forming the two-state defects is inversely dependent on the amount of illumination used in revealing the defects. Of the defects not ionized by light, a few disappear and the remainder form the two-state defect. The two-state defect breaks up when the temperature is raised to about 200°K. This breakup results in an introduction of stable donors and the removal of acceptor levels from the chemical states. Evidence for the existence of recovery stages which depend on the doping material is found for impurities having smaller atomic number than Ge. These impurity-dependent recovery stages occur at different temperatures according to the type of impurity used. After the two state defect breaks up, p-type Ge is found to be very stable up to temperatures near 400°K. However, if irradiations near 0°C are performed on high purity samples a complex defect is produced which diffuses with an activation energy of about 0.36 eV. Quenching the samples to liquid nitrogen temperature prior to the completion of the anneal produces a peak in the Hall coefficient at about 200°K. The peak arises because of a reversible rearrangement of the complex during the temperature cycle causing a change in the electronic level structure. After the annealing comes to completion an energy level near 0.2 eV is observed. Another level which depends on the impurity type is also present when the annealing is completed. It is believed that the final state is an association of an interstitial with an impurity atom. (Disser. Abstr.)

33544 DYNAMIC SCATTERING OF PARTICLES BY PERFECT CRYSTALS. Howsmon, Alan Johnston. Lafayette, Ind., Purdue Univ., 1966. 82p.

Thesis.

The scattering of particles having no internal degrees of freedom from a perfect harmonic crystalline sample was studied. Examples of such particles are thermal neutrons, photons in the x-ray range, slow electrons, and monatomic atoms with excited state energies greater than the available energy for atomic transitions. The crystal is assumed to be constructed of monatomic cells. The harmonic approximation is made on the crystalline potential energy. The interaction of the particle with the crystal is described by an interaction potential which acts between the incident particle and each of the crystalline atoms. The approach used for the solution of this problem is that of quantum mechanical scattering theory. The equation for the scattered state vector is in the form of an integral equation. In order to solve this the particle state vector within the crystal is approximated with the general form of a Bloch wave. Upon using this approximation the differential cross section for the scattering event is found by the customary procedure. This solution gives the probability of finding the particle in some final state given the initial state of the particle and the initial state of the crystal. The formal differential cross section is found to consist of a sum of differential cross sections each of which represents a different order of energy exchange between the particle and the crystal. This energy exchange is expressed in terms of the creation or annihilation of crystal phonons. In addition to the amplitude for a given energy exchange, the amplitude for scattering in a given direction is found to depend upon the atomic scattering factors, the Debye–Waller factor, the particle wave amplitudes within the crystal, and phase relations which account for the scattering from the different crystal atoms. For low-energy incident particles such that the crystal surface cannot be neglected the phase relations show there to be a surface reflection together with a surface diffraction. For high-energy incident particles such that the crystal surface may be neglected the phase relations show there to be a three-dimensional diffraction from the crystal. The formal solution is applied to several specific examples which are shown to reduce to well known results upon making the appropriate simplifying assumptions. Several problems are suggested to which the formal solution could be applied for which there presently exists no general solution. (Disser. Abstr.)

33545 MOESSBAUER EFFECT IN SURFACE STUDIES, ^{57}Fe ON Ag. Godwin, Robert Paul. Urbana, Ill., Univ. of Illinois, 1966. 98p.

Thesis.

The Moessbauer effect for atoms located at crystal surfaces is discussed. It is shown that the Einstein model is valid for describing qualitatively the mean square displacement of lattice atoms. The mean square displacement (Moessbauer recoilless fraction) and mean square velocity (Moessbauer second-order Doppler shift) of atoms in one- and three-dimensional crystals with free surfaces are treated in a many-body approach. The simple models indicate that at high temperatures surface atom mean square displacements are on the order of twice bulk atom mean square displacements (or equivalently that surface atom Debye temperatures are about $1/\sqrt{2}$ times the corresponding bulk values) and that surface effects penetrate only a few atomic spacings into a crystal. A possible temperature dependence of the Moessbauer isomer shift due to anharmonic binding forces at surfaces is pointed out. The experimental difficulties faced in a surface Moessbauer study performed under ultrahigh vacuum conditions and the apparatus used in an attempt to overcome them are described. Moessbauer spectra of ^{57}Fe on LiF, in Ag, and on Ag have been obtained in the temperature range 100 to 400°K. The LiF experiment is assumed to be a measurement of Fe on W which had contaminated the LiF. This experiment yielded a broad line which we interpret as a quadrupole split pair of lines due to a field gradient normal to the surface of about -4×10^{16} volts/cm^2. The Fe in Ag experiment gave a single narrow line shifted at room temperature (0.056 ± 0.002) cm/sec with respect to iron in iron, a temperature gradient of line position $-(7.5 \pm 0.5) \times 10^{-5}$ cm/(sec deg), and an effective Debye temperature obtained from the temperature dependence of the recoilless fraction of (253 ± 12)°K. The Fe on Ag measurements yielded an asymmetric line interpreted as a quadrupole split line due to a field gradient of -3×10^{16} volts/cm^2. A very small isomer shift with respect to iron in iron was observed along with a temperature dependence of the line position of $-(5.1 \pm 0.6) \times 10^{-5}$ cm/(sec deg). An effective Debye temperature of (380 ± 30)°K was found for Fe on Ag. (Disser. Abstr.)

33546 RECOMBINATION LIFETIMES IN GAMMA-IRRADIATED SILICON. Hewes, Ralph Allan. Urbana, Ill., Univ. of Illinois, 1966. 174p.

Thesis.

The small-signal recombination lifetimes of minority carriers were measured as a function of temperature in silicon before and after irradiation at room temperature by ^{60}Co γ rays. The resistivity of the boron doped samples ranged between 10 and 5000 ohm-cm, and the resistivity of the phosphorus doped samples was between 20 and 220 ohm-cm. Both crucible and floating zone grown materials were investigated. The radiation-induced lifetime changes were interpreted by the theory of Hall and Shockley and Read. The lifetime changes in n-type material were interpreted to be due to two energy levels, one 0.17 eV from the conduction-band edge, which was assumed to be the substitutional oxygen (A center) defect, and the other at 0.4 eV from the conduction-band edge. On the basis of annealing data, it appeared that the 0.4-eV level could be due to several defects whose energy levels coincided, but that most of the recombination in the float-zoned material occurred through the donor-vacancy complex (E center). The introduction rates of the levels were not strongly influenced by differences in resistivity, but the introduction rate of the 0.4 eV level was much less in material containing large oxygen concentrations. Defects controlling the lifetime in irradiated p-type material were placed at 0.18 eV above the valence band edge and at 0.3 eV below the conduction band edge. The former level could possibly be located 0.18 eV below the conduction band edge, but it is most unlikely that it is the A center because of the ratio of the hole and electron capture cross sections. The 0.18-eV level controlled the lifetime in the room temperature region in the pulled material, and the 0.3-eV level controlled the lifetime at all measured temperatures in float-zoned material whose resistivity was 70 ohm-cm or greater. The ratio of the hole to electron capture cross section for the 0.3-eV level was about 20. No strong effect of resistivity was seen in either of the p-type silicon, but the effect of the larger oxygen content of the pulled material was to reduce the introduction rate of the 0.3-eV level. (Disser. Abstr.)

33547 PRODUCTION AND RECOVERY OF POINT DEFECTS INTRODUCED INTO COPPER AND ALUMINUM WITH ELECTRON IRRADIATION AT 6°K. Iseler, Gerald William Emil. Evanston, Ill., Northwestern Univ., 1966. 95p.

Thesis.

Point defects are small crystalline imperfections which have a very important place in modern solid state physics. Although they are expected to be most simple in the simple metals, very little (beyond speculation) is known about them even in copper and gold. The ultimate goal of point defect research is to quantitatively describe the role that the defects play in influencing the physical properties of a solid. In order to approach this goal one must attempt to understand the nature of the production, structures and migration of the defects. This work was an attempt to increase the understanding of the production mechanism of Frenkel defects introduced into copper by bombardment with 0.15- to 2.1-MeV electrons at liquid helium temperature and to gain some information about the structures and the migration of these defects by studying their isochronal recovery when the temperature is increased in 3/4°K intervals. The rate of production of electrical resistivity was measured over an energy range large enough to accurately determine the threshold energy and to estimate the displacement probability function. Threshold energies for displacement are 19 and 16 eV for copper and aluminum, respectively. The Kinchin and Pease model for a multiple displacement probability function fits the copper and the aluminum production data quite well but the calculated resistivities per Frenkel pair are lower than other reported values for lattice vacancies alone. The main conclusion from the present recovery study is that the Stage-I recovery spectra of electron irradiated copper and aluminum (negative derivatives of resistivity with respect to temperature versus temperature curves from 10 to 60°K) are more complex than suggested before. For copper fifteen local maxima were observed between 10 and 60°K, each of them representing a first order reaction. This was determined from the fact that they did not shift in temperature when the dose was changed by a factor of 8. The recovery peaks in the 10 through 40°K range are interpreted in terms of close pair recombinations. At about 45°K, free migration of interstitials must occur as well as some first order processes. This is supported, for instance, by the response to radiation doping at 78°K. Also, the observed dose dependence of the peak heights in the 45°K region can be explained with the concept of freely migrating interstitials. These peaks have something to do with interactions between interstitials and dislocations, but their complex nature remains, as yet, largely uncertain. The recovery spectrum of aluminum is very similar to that of copper. There are peaks in which the amount of recovery depends on the energy of the incident electrons in the same way as that of the copper peaks. The recovery up to 40°K is attributed to close pair recombinations as is that of copper. The relative peak heights change with dose between 40 and 48°K. This is thought to be due to the simultaneous occurrence of first order recovery processes and a higher order reaction which is attributed to the long range migration of interstitials. The recovery between 48 and 60°K is more pronounced due to prior deformation and much smaller due to radiation doping at 78°K. (Disser. Abstr.)

Theoretical Physics

Refer also to abstracts 33059, 33061, and 33091.

33548 (AAEC/TM-382) SUM RULES IN THE GEMINAL EXPANISON OF MANY-ELECTRON WAVEFUNCTIONS. Brown, R. J. C. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr. 1967. 6p. Dep.

An interpretation of certain sum rules in the method of Bopp is given in terms of the irreducible representations of the rotation group. It is accompanied by a simple numerical table, from which the sum rules may be obtained by inspection. (auth)

33549 (ITF-67-2) CONNECTION OF TWO-TIME TEMPERATURE ADVANCED AND RETARDED GREEN FUNCTIONS METHOD WITH KINETIC EQUATIONS IN STATISTICAL MECHANICS. Sadovnikov, B. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 90p. Dep.

Quantum statistical Green function method is one of the most fruitful trends in investigating many-body problems. In particular, when investigating transport processes it is used instead of more elementary methods based on the usual kinetic equations. The relation is established between the two-time advanced and retarded-temperature Green functions, both quantum and classical, and the kinetic equations of statistical mechanics. (W.D.M.)

33550 (NP-16843) TOTAL NUMBER OF PARTICLES AND FOCK REPRESENTATION. Note No. 90. Dell'Antonio, G. F.; Doplicher, S. (Rome Univ. (Italy). Istituto di Fisica). Mar. 1, 1966. 10p. Dep.

It is proved that an average number of particles can be defined only in those representations of the canonical commutation (or anticommutation) relations which are multiples of the Fock–Cook representation. (auth)

33551 (TID-23694) HOW TO UNDERSTAND SPECIAL RELATIVITY. Ruark, Arthur E. (Division of Research (AEC), Washington, D. C.). Sept. 1966. 18p. Dep. CFSTI.

The basic phenomena of special relativity are usually derived

from the symmetry of the physical experiences of two observers on inertial frames, and the assumption that both observers obtain the same value of the speed of light, no matter how the source is moving. Here the second postulate is replaced by the statement that the Maxwell equations and the Lorentz force are valid for the "resting" observer. A simple clock, a negative charge, rotating around a heavy positive charge in a plane perpendicular to the x axis is discussed. If this system is set into uniform motion along that axis, it becomes the clock of the observer moving with it. The "resting" observer can use the retarded potentials of a point charge in uniform motion to discuss its behavior. A few lines then suffice to derive the mass increase and the decrease of angular velocity which are seen by the "resting" observer. The expansion of time intervals associated with a moving body, the constancy of light velocity for both observers, the Lorentz contraction of a moving body, and the Lorentz transformation follow in order, with ease. It becomes clear that the altered behavior perceived by the "resting" observer is brought into being by the process of accelerating an experimental apparatus to bring it into its final state of uniform motion. (auth)

33552 TIMELIKE HELICES IN FLAT SPACE–TIME. Synge, J. L. (Dublin Inst. for Advanced Studies). Proc. Roy. Irish Acad., Sect. A, 65: No. 3, 27-34(Jan. 1967).

Time-like helices in flat space–time are classified into types and subtypes, six in all, according to the relative magnitudes of the three curvatures. The curves are examined in detail and parametric equations obtained. It is shown that the world-line of a charged particle moving in a constant electromagnetic field is a helix. All six types and subtypes of helix are obtained, corresponding to different types of electromagnetic field and different initial conditions for the trajectory. (auth) (UK)

33553 GENERAL PRINCIPLES OF ASYMPTOTIC COMPUTATION OF THE INTERACTION OF CHARGES WITH SPACE-MODULATED MAGNETIC FIELDS. Kovtun, R. I. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 139-40(Jan.-Feb. 1967). (In Russian).

The general method of asymptotic approximation of Krylov–Bogolyubov is applied to the analysis of the motion of charges in a strong magnetic field with arbitrary perturbation which depends on all three coordinates. The case considered utilizes cylindrical geometry, by which the problem can be put into the quasi-harmonic form with weakly varying coefficients. The variation of the coefficients is described by two first-order equations. The equations of motion are rewritten in terms of new variables. They show that for very small perturbations of the field the motion of the charge approaches that described by Larmor orbits. The dominant orders are first and second; the third order affects only paraxial motion to a small extent. (ATD)

33554 TWO THEOREMS ON THE VARIATION PERTURBATION METHOD FOR THE EXCITED STATES OF STATIONARY QUANTUM SYSTEMS. Sharma, C. S. (London Univ.). Proc. Phys. Soc. (London), 91: 50-3(May 1967).

Two theorems are proved which are of considerable use in understanding the situation which arises while applying the variation perturbation method for calculating the state vectors and the energies of stationary quantum systems. These theorems also enable ensurance that the second-order energy calculated by the use of the method is a rigorous upper bound to the true value. The earlier results of Sinanoglu [Phys. Rev., 122: 491-2 (1961)] and Miller [J. Chem. Phys., 44: 2198-9(1966)] follow as immediate corollaries of these theorems. (auth) (UK)

33555 A NOTE ON THE RAINICH PROBLEM. Dowker, J. S. (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 91: 23-4(May 1967).

The Rainich conditions for electrovac space–times are derived using Rumer's form of Maxwell's equations. The analysis is based on the 2j + 1 representations of the Lorentz group directly, rather than on their tensor or two-spinor equivalents. (auth) (UK)

33556 LORENTZ TRANSFORMATION OF THERMODYNAMIC QUANTITIES. II. Pathria, R. K. (Univ. of Alberta, Edmonton). Proc. Phys. Soc. (London), 91: 1-7(May 1967).

Relativistic transformation formulae for thermodynamic quantities are obtained without having recourse to integrations in the phase space. The controversial role of the Jacobians of transformation is thereby completely eliminated. The discussion is in terms of the distribution of particles over discrete quantum states throughout; nevertheless, paying due regard to the relativity of temporal measurements (which enter into the time-averaging of every statistical quantity), the old Planck–Einstein formula is again obtained. The correspondence between the physical features of this approach and the one followed in an earlier paper [Pathria, Proc. Phys. Soc., 88: 791-9(1966)] on this subject has been elucidated. (auth) (UK)

33557 ZILCH OF GRAVITATIONAL FIELDS. Dowker, J. S. (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 91: 28-30(May 1967).

Lipkin's [J. Math. Phys., 5: 696-700(1964)] "Zilch" for a massless spin-2 particle is extended to a generally covariant form and is shown to be covariantly conserved. (auth) (UK)

33558 ELECTRODYNAMIC PROPERTIES OF A GAS OF SPIN-1/2 PARTICLES IN A UNIFORM MAGNETIC FIELD. Arunasalam, V. (Princeton Univ., N. J.). Contract AT(30-1)-1238. Phys. Rev., 158: 234-46(June 10, 1967). (MATT-475).

A rather complete discussion of the electrodynamic behavior of a gas of spin-½ particles in a uniform external magnetic field is presented. The method presented here is based on the general principles of elementary nonrelativistic quantum theory and takes account of the Doppler-broadening effects arising from the random thermal motion of the particles and the Compton recoil effects arising from the emission (spontaneous plus the induced or the stimulated emission) and absorption of photons by the spin-½ particles. In the first half of the paper a method is presented for calculating the spin permeability tensor which determines the propagation of transverse electromagnetic radiation through a gas of spin-½ particles in a uniform external magnetic field. It is shown that the spin permeability tensor thus obtained yields the familiar results of solid-state physics, such as the nuclear and electronic-spin radiofrequency susceptibility and the spin paramagnetism. In the second half of this paper the subject of spin–radiative equilibrium of a gas of spin-½ particles in a uniform external magnetic field is discussed in some detail. Simple closed-form expressions for the steady-state photon number density and the spin–radiative relaxation time of the system under study are thus derived. It is shown that the steady-state photon number density is the familiar distribution function corresponding to Bose–Einstein statistics for "complete thermodynamic equilibrium." The conditions under which the system of spin-½ particles in a uniform magnetic field can become unstable for transverse electromagnetic radiations are also discussed. (auth)

33559 THEORY OF A SYSTEM CONTAINING AN ARBITRARY NUMBER OF DIFFERENT INTERACTING BOSE SPECIES. Etters, Richard D. (Douglas Advanced Research Labs., Huntington Beach, Calif.); Raich, J. C. Phys. Rev., 159: 146-53 (July 5, 1967).

A theory that describes the dynamic behavior of a system containing an arbitrary number of different interacting Bose species is developed. The excited eigenstates of the system are generated by the superposition of plane-wave creation- and annihilation-operator products $\mu_k^\dagger = \Sigma_\gamma \Sigma_p g(p,k,\gamma)\, a_{p,k}^\dagger(\gamma) a_p(\gamma)$, where the c-number coefficients $g(p,k,\gamma)$ are determined by solving the equation of motion for $\mu_k^\dagger$ in an approximate way. The sum over γ extends over all different species of the system. The equation of motion is solved by a method similar to that originally derived by Pines and Bohm for the electron gas. Results are obtained for the energy spectrum of the elementary excitations in the system. In particular, explicit results are obtained for the energy spectrum of a two-species system—first for a weakly coupled gas, and secondly for the low-momentum collective modes of a strongly coupled fluid. The low-momentum excitations of the strongly coupled fluid are completely analogous to the zero sound modes commonly associated with Fermi liquids. The theory is then applied to a dilute mixture of ^{3}He in ^{4}He and the phonon velocity is determined as a function of ^{3}He concentration. The probability per unit time $P(k,\omega_k)$ that a particle transfers momentum k and energy ω_k to the system by scattering is also calculated in terms of the dynamic form factor $S_\gamma(k,\omega)$. (auth)

33560 THEORY OF A CHARGED BOSE GAS. II. Woo, Chia-wei; Ma, Shang-keng (Univ. of California, San Diego, La Jolla). Phys. Rev., 159: 176-83(July 5, 1967).

The simultaneous effects of the condensate and of the long-range nature of the interaction have made the high-density charged Bose gas an interesting theoretical problem. A straightforward procedure that takes these effects into account is presented. It is based on the perturbation theory in the Bogolyubov representation and the principle of the compensation of dangerous diagrams. Both the ground-state energy and the excitation spectrum are studied. Numerical results are given for the first two orders in $r_s^{\frac{1}{2}}$. The ground-state energy reduces to that calculated correctly by Brueckner, and earlier by Lee and Feenberg in a variational treatment. The excitation spectrum agrees with that calculated in the preceding paper using an entirely different method. (auth)

33561 THEORY OF A CHARGED BOSE GAS. I. Ma, Shang-keng; Woo, Chia-wei (Univ. of California, San Diego, La Jolla). Phys. Rev., 159: 165-75(July 5, 1967).

In the first of two papers in which the high-density charged

Bose gas at zero temperature is treated by two independent and self-contained methods, the excitation spectrum of the system is considered. An analysis of the formal and physical aspects of the theory is followed by a simple numerical calculation. The usual field-theoretic formulation for a Bose system is applied. The Green's functions and other response functions, or propagators, are analyzed, emphasizing the role of the dielectric constant. The general features of the excitation spectrum are described. To apply and to further illustrate the formalism, the low-lying levels are numerically determined to the order of r_s^4 in units of ω_{pl} (the next order beyond the Bogolyubov approximation). r_s is the ratio of the average interparticle distance to the Bohr radius and ω_{pl} is the plasma frequency. (auth)

33562 APPROACH TO THE BOUND-STATE THREE-BODY PROBLEM WITH APPLICATION TO THE HELIUM-LIKE ATOM. Jasperse, J. R. (Air Force Cambridge Research Labs., Bedford, Mass.); Friedman, M. H. Phys. Rev., 159: 69-86(July 5, 1967).

A technique is presented for treating a general type of three-body bound-state problem for situations where the interaction may be written as the sum of three pair potentials. The method is based on the work of Eyges and consists of writing the total wave function for the three-body problem in a special form, i.e., as the sum of three different parts or orbitals defined in a natural way from the integral equation by using the appropriate symmetrized or antisymmetrized Green's function. A set of three integral equations for the three orbitals is derived: first for the situation where each particle is distinguishable, and then for situations where two or all of the three particles are identical. It is found that, when some of the particles are identical and the Pauli principle is incorporated into the formulation, the number of independent orbitals can be reduced. Some simple one-dimensional applications involving δ-function pair potentials are examined. The helium atom is discussed from a three-body point of view in order to illustrate the general approach to the above-mentioned set of coupled integral equations. Each orbital is expanded into a complete set of two-body Sturmian functions for the Coulomb potential. For states in atomic helium of the form L = 0, the equations assume a simplified form. For these states, the infinite set of integral equations in one variable generated by the expansion is truncated at several orders and solved numerically. Rapid convergence is demonstrated for low-lying states of the helium-like atoms using this method. In particular, results are reported for the $1s1s\,^1S$, $1s2s\,^1S$, and $2s2s\,^1S$ states of He, Li^+, and H^-. The technique is not based upon a perturbation expansion or a variational principle. (auth)

33563 SIMPLE FORMULA FOR ENERGY RADIATION. Infeld, L. (Inst. of Theoretical Physics, Warsaw, Univ. of Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 293-5(1967).

An attempt is made to formulate a classical and general formula for radiating systems of particles which would be in periodic motion if not for their loss of energy through radiation. (W.D.M.)

33564 ON THE THEORY OF BROWNIAN MOTION IN A QUANTUM FLUID. II. THE LOW-TEMPERATURE LIMIT. Resibois, P.; Dagonnier, R. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg. (5), 52: 1475-1506(1966).

A brief summary is given of the main formal results derived in Paper I. A detailed analysis is presented of the equilibrium properties of a quantum B particle in a fluid of light particles. The explicit structure of the operators $G^{(3)}$ and $\Omega^{(4)}$ are considered, and it is shown that part of these terms may be interpreted as renormalization of the unperturbed Fokker–Planck equation. Some remarks on the approach to equilibrium and some lengthy calculations are given. (W.D.M.)

33565 CONSTRUCTION OF A DEFINITE EXPRESSION FOR THE PARTICLE DENSITY OF KLEIN–GORDON FIELDS. Gerlach, Bernd; Gromes, Dieter; Petzold, Joachim (Univ., Marburg, Ger.). Z. Phys., 204: 1-11(1967). (In German).

An expression for a charge density of the Klein–Gordon field is constructed which is the 0 component of a four-vector as well as positive-definite if one confines oneself to positive frequency solutions only. The latter is not the case for the usual density as was shown in a preceding paper. (auth)

33566 DESCRIPTION OF NOISE IN QUANTUM SYSTEMS. Bausch, R.; Stahl, A. (Technische Hochschule, Aachen). Z. Phys., 204: 32-46(1967).

A formalism of probability operators which generalizes the notion of density operator is introduced into the theory of noisy quantum systems. The Markov property and the connection between the Heisenberg and Schrödinger picture for systems undergoing an irreversible change are discussed in detail. The probability-operator treatment of noise is related to the Langevin method discussed by Lax through a generalized Einstein relation. The master equation for the quantum mechanical oscillator with linear damping is written down in a Fokker–Planck-type approximation. By means of the Einstein relation the coefficients in the Fokker–Planck equation are related to the parameters in the phenomenological equations. (auth)

33567 THE CENTER-OF-MASS IN EINSTEINS THEORY OF GRAVITATION. Beiglboeck, W. (Univ., Heidelberg). Commun. Math. Phys., 5: 106-30(1967).

The existence and uniqueness of a center-of-mass line as well as a center-of-motion line, the latter due to G. Dixon (1964), are considered. The validity of the theorems depends on some assumptions whose most restrictive ones (in the sense of physics) state a certain weakness of the gravitational field. Some corollaries and a very simple application to the problem of motion are given. (auth)

33568 THE CHAPMAN–ENSKOG SOLUTION OF THE BOLTZMANN EQUATION: A REFORMULATION IN TERMS OF IRREDUCIBLE TENSORS AND MATRICES. Kumar, Kailash (Australian National Univ., Canberra). Austral. J. Phys., 20: 205-52(June 1967).

The Chapman–Enskog method of solving the Boltzmann equation is presented in a simpler and more efficient form. For this purpose all the operations involving the usual polynomials are carried out in spherical polar coordinates, and the Racah–Wigner methods of dealing with irreducible tensors are used throughout. The expressions for the collision integral and the associated bracket expressions of kinetic theory are derived in terms of Talmi coefficients, which have been extensively studied in the harmonic oscillator shell model of nuclear physics. These expressions are most convenient for exhibiting some formal properties and can be programmed for machine computations in the most general form. The Chapman–Enskog linearization leads to linear matrix equations whose solutions can be expressed compactly in matrix notation. Calculations of transport coefficients up to any order can be performed almost automatically, without requiring the elaborate manipulations in each new order as is the case with the usual theory. The simple gas is treated in detail, and the treatment for the case of a gas mixture is outlined. All calculations were carried out without reference to the theory of integral equations. The role of summational invariants and of the subsidiary conditions becomes more transparent in this presentation. The relation of the formulation to the usual one is also discussed. (auth)

33569 ON A WAVEFUNCTION PICTURE FOR THE DIRECT PARTICLE THEORY OF GRAVITATION AND ELECTROMAGNETISM. Hoyle, F.; Narlikar, J. V. (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A, 299: 188-211(June 14, 1967).

The direct particle theory developed in previous papers is reviewed. A new result is obtained, that while long-range gravitational forces are necessarily attractive very short-range forces must be repulsive. The theory for strong gravitational fields differs radically therefore from general relativity. In general relativity a finite particle collapses into a singularity. Here a singularity explodes into a finite particle. The concept of a finite particle is explored and the particle is treated as a classical world tube. A further new result emerges, that the inertial mass of such a particle must be very small. The gravitational mass is the same as in the line singularity case, but a particle represented by a world tube shields its inertial mass through its own influence on the metric tensor. It is suggested that the very small ratio of gravitational to electrical forces may be due, not to the weakness of gravitation but to the smallness of the inertial mass. The advantage of this suggestion is that no very large dimensionless number need appear in the action formula. A wavefunction picture for the particle is presented. An action principle is used that leads to the Dirac equation for the particles. The field equations are the same as in the line singularity case, except that the energy–momentum tensor associated with matter is changed from the form used in general relativity to the form that is usual for a Dirac "field." The wave-function picture, as developed, contains the simpler ideas of the quantum theory—the superposition principle, stationary states, the quasi-classical theory of radiative transitions. No attempt is made to extend the theory to include effects that are particular to quantum electrodynamics. (auth) (UK)

33570 GRAVITATIONAL WAVES. von Krzywoblocki, M. Z. (Michigan State Univ., East Lansing). Acta Phys. Acad. Sci. Hung., 23: 193-202(1967).

Some characteristic features of gravitational waves are briefly discussed. The present technique of the calculation of the velocity of the propagation of the gravitational waves by means of the small

perturbation technique is described. A counter example is calculated which shows that the perturbation technique gives the calculated velocity of the gravitational waves different from the velocity of the propagation of light which seems to imply that the technique in question may not be strong enough to furnish the correct answer. (auth)

33571 NONRELATIVISTIC APPROXIMATION OF THE DIRAC CURRENT. Huszar, M. (Central Research Inst. for Physics, Budapest). Acta Phys. Acad. Sci. Hung., 23: 225-36(1967).

By making use of the Foldy–Wouthuysen transformation the nonrelativistic charge and current density is derived from the Dirac equation up to the second order in p/mc. The terms obtained in addition to nonrelativistic Pauli charge and current density are interpreted as follows. The moving magnetic dipole corresponds to an electric one interacting with the electric field like a polarization charge $\rho_\pi = -\text{div } \pi$. The current corresponding to this polarization charge appears in the usual form $\partial\pi/\partial t$. The Thomas precession gives the contributions $\rho_T = (1/2)\text{ div } \pi$ and $j_T = -(1/2)(\partial\pi/\partial t)$ to the charge and current density, respectively, and, thus, only half of the polarization charge and current is effective. An $E \times \sigma$ type term arises in the current since the mechanical and canonical momenta are not now simply related through $m\gamma v = p - (e/c)A$. An additional Darwin-type term arises in the charge density which cannot be interpreted classically. (auth)

33572 APPROXIMATION METHOD FOR SOLUTION OF THE EINSTEIN–MAXWELL EQUATION FOR A POINT PARTICLE WITH A MAGNETIC DIPOLE MOMENT. Nottrott, J. (Univ., Jena, Ger.). Acta Phys. Pol., 31: 1001-19(1967). (In German).

An approximation method was developed for successive solution of Einstein–Maxwell field equations. For problems that are possible to treat in the Weyl canonical cylinder coordinates, $ds^2 = e^{\lambda}(dt^2 + dr^2) + e^{-\rho}r^2d\theta^2 - e^{\rho}c^2dt^2$, higher approximations of field equations may be obtained without integration. The method was used for solution of the field equations for a point particle that carries a magnetic dipole. By overlapping the "pure dipole solution" and the Schwarzschild solution specific beginning values are offered from which higher approximations may be made by differentiation and algebraic processes. The convergence of the obtained series is estimated. The motion of an uncharged test particle in the superimposed field is discussed. (tr-auth)

33573 GENERAL RELATIVISTIC THEORY OF LAGRANGIAN FUNCTIONS. PART I. SCALAR AND VECTOR FIELDS IN THE SPACE X_1. Knapecz, G. (Univ. of Technical Sciences, Budapest). Acta Phys. Acad. Sci. Hung., 23: 145-60(1967).

A deductive method is given for the derivation of general relativistic Lagrangian functions (densities). The method consists of the solution of a functional equation which is equivalent to the Lie equation. Some exact solutions of this equation are given. Whenever a Lagrangian density of the supposed type does not exist, the mathematical proof of the nonexistence is given. (auth)

33574 HERGLOTZ–NOETHER THEOREM IN CONFORMAL SPACE–TIME. Wahlquist, Hugo D.; Estabrook, Frank B. (California Inst. of Tech., Pasadena). Contract NAS7-100. J. Math. Phys. (N. Y.), 8: 919(Apr. 1967).

The Herglotz–Noether theorem is proved for rigid motions in conformal space–time. (auth)

33575 NULL FIELDS IN EINSTEIN–MAXWELL FIELD THEORY. II. Trollope, J. R. (Univ. of Alberta, Can.). J. Math. Phys. (N. Y.), 8: 938-41(Apr. 1967).

If the propagation vector of an electromagnetic null field is proportional to a gradient, then the metric tensor can be expressed in terms of only four unknown functions. In the present analysis, it is assumed that the divergence of this vector does not vanish. It is shown that the field equations reduce to a single partial differential equation. Particular solutions which represent electromagnetic and purely gravitational waves are given. (auth)

33576 CLOSURE RELATIONS FOR THE EIGENFUNCTIONS OF THE ONE-SPEED TRANSPORT EQUATION. Kuscer, I.; Shure, F. (Univ. of Michigan, Ann Arbor). J. Math. Phys. (N. Y.), 8: 823-6(Apr. 1967).

Orthogonality relations for the eigenfunctions of the one-speed transport equation are used to derive the corresponding closure relations. These express in a concise form the completeness properties previously proved by Case. (auth)

33577 EINSTEIN EQUATIONS AND ELECTROMAGNETISM. Lanczos, C. (Dublin Inst. for Advanced Studies, Dublin, Yale Univ., New Haven). J. Math. Phys. (N. Y.), 8: 829-36(Apr. 1967).

Einstein's equations for infinitesimal gravitational fields are investigated from the standpoint of replacing Einstein's flat Minkowskian background space by a strongly agitated Riemannian lattice space, with the added demand that the perturbation field be of very low frequency compared with the lattice frequency. It is found that the strongly nonlinear lattice transmits low-frequency perturbations only if the perturbation field satisfies a set of field equations which become practically identical with Maxwell's equations. While this result demonstrates the close relation between Einstein equations and electromagnetism, it also opens a new door toward the deeper understanding of the quantum phenomena. (auth)

33578 NECESSARY CONDITIONS ON RADIAL DISTRIBUTION FUNCTIONS. Wu, F. Y. (Virginia Polytechnic Inst., Blacksburg); Tan, H. T.; Feenberg, E. J. Math. Phys. (N. Y.), 8: 864-9(Apr. 1967).

Certain necessary conditions must be met by any function introduced to serve as a radial distribution function of a uniform N-particle system. One large class of necessary conditions is based on the statement that the expectation value of a potential energy (for an arbitrary potential function between pairs of particles) cannot fall below the classical minimum potential energy of the system. To convert this statement into a family of useful inequalities, the classical potential energies of close-packed crystals for a linear combination of Yukawa and Coulomb two-particle interactions were evaluated. The numerical evaluation of lattice sums is performed by two procedures: (1) direct summation over the lattice (suitable for short-range potentials), and (2) an adaptation of the Ewald summation procedure suitable for long-range potentials. Results are given for the Coulomb and Yukawa potentials and also for the potentials $1/r(r + a)$ and $1/r(r + a)^2$. Two simple approximate forms are developed both giving close lower bounds on the classical potential energy of interacting particles forming a regular crystalline lattice. (auth)

33579 ENERGY TENSOR OF THE NULL ELECTROMAGNETIC FIELD. Bartrum, P. C. J. Math. Phys. (N. Y.), 8: 667-74(Apr. 1967).

The differential conditions are obtained which must be satisfied by the energy tensor of a null, source-free electromagnetic field. At the same time a method is indicated for determining the electromagnetic field when the energy tensor satisfying the necessary conditions is given. (auth)

33580 NULL TETRAD APPROACH TO MOTIONS IN EMPTY SPACE–TIME. Collinson, C. D.; French, D. C. (Univ. of Hull, Eng.). J. Math. Phys. (N. Y.), 8: 701-8(Apr. 1967).

The integrability conditions of conformal motions are written in the null tetrad formalism of Newman and Penrose. The maximum order of the group of conformal motions admitted by nonflat empty space-times of given Petrov type is shown to be at most one greater than the maximum order of the group of Killing motions. The symmetries of those empty space–times which possess hypersurface orthogonal geodesic rays with nonvanishing divergence are determined. Among these space–times is one of type III which admits a group of Killing motions of order three. This provides a counter example to a result of Petrov which states that the maximum order of the group of Killing motions for such space–times is two. (auth)

33581 TOPOLOGY IN GENERAL RELATIVITY. Geroch, Robert P. (Princeton Univ., N. J.). J. Math. Phys. (N. Y.), 8: 782-6(Apr. 1967).

A number of theorems and definitions which are useful in the global analysis of relativistic world models are presented. It is shown in particular that, under certain conditions, changes in the topology of spacelike sections can occur if and only if the model is acausal. Two new covering manifolds, embodying certain properties of the universal covering manifold, are defined, and their application to general relativity is discussed. (auth)

33582 ESTABLISHMENT OF THE ENERGY-MOMENTUM TENSOR OF THE GENERAL RELATIVITY THEORY ON THE BASIS OF A KINETIC MODEL OF MATTER. Audretsch, Juergen (Univ., Freiburg i. B.). Z. Naturforsch., 22a: 808-15(May 1967). (In German).

The energy–monentum tensor $T^{\alpha\beta}$ of the general theory of relativity is investigated on the basis of a kinetic model of matter (point particles). Its freedom of divergence results from the motion of the particles. After a suitable decomposition of $T^{\alpha\beta}$ into its invariant components these can be interpreted in a generally covariant manner according to their microstructure. By means of the distribution of matter special time-like world lines are designated as stream lines. The freedom of divergence of $T^{\alpha\beta}$ can be interpreted by virture of the model as a local balance of energy and momentum. In this balance the influence of gravitational and inertial forces becomes immediately evident. Pressure results as a function of the particle properties (state equation). (auth)

33583 CORRELATION OF PHOTONS FROM A THERMAL SOURCE. Ma, Shang-keng. Berkeley, Calif., Univ. of California, 1966. 114p.

Thesis.

The amplitude and the intensity correlation of photons from a model thermal source are studied. The objective is to express the photon correlation functions in terms of the parameters describing the source. The source model is analyzed utilizing the temperature Green's function method. The power spectrum (line shape) is computed numerically for some special cases. General properties of temperature Green's functions are also studied. (Disser. Abstr.)

33584 THE COMPLEX INHOMOGENEOUS LORENTZ GROUP AND COMPLEX ANGULAR MOMENTUM. Roffman, Eric Hillel. Waltham, Mass., Brandeis Univ., 1966. 106p.

Thesis.

It is shown that two of the most important properties of complex angular momentum—the property of generalizing integral or half integral angular momentum, and the property of characterizing the asymptotic behavior of the S matrix in the crossed channel—can be obtained from group theoretical arguments. These properties are interpreted as consequences of the invariance of the S matrix under the complex inhomogeneous Lorentz group. The irreducible representations of this group are constructed, the Kronecker product of two representations into irreducible parts is reduced, and an S matrix invariant under the group is constructed. The method is related to previous attempts at group theoretical discussions of complex angular momentum. The advantages of the method used are that there is no need to assume the Mandelstam representation and one is able to describe explicitly the transformation properties under the Poincaré group of an object with "complex angular momentum"—it transforms like a reducible representation with many spin values. It is possible to derive asymptotic formulae for the S matrix in the crossed channel similar to those obtainable in the theory of Regge poles. (Disser. Abst.)

33585 QUANTUM MEASUREMENT EXAMPLE. Holze, Dick Henry. Reno, Nev., Univ. of Nevada, 1965. 152p.

Thesis.

Although it is common in quantum measurement theory to consider through experiments in which positions and momenta for one particle are measured by causing it to collide with a second which is part of the measuring apparatus, the problem has never been treated in full quantum detail. Here such a treatment is presented for the nonrelativistic, one-dimensional, perfect-reflecting collision of two Gaussian wave packets. From simultaneous momentum–time measurements on the measuring particle, number 2, information concerning the position and momentum of the measured particle, number 1, is obtained both for a single measurement interaction and an ensemble. Because quantum mechanics requires the use of a two-dimensional treatment, momentum measurements on particle 2 will be correlated with those on particle 1. The only position of particle 1 which is meaningful for measurement is the collision position, X_c. A special definition for the position measurement in terms of the intersection of the paths (with appropriate quantum spreads) of particle 2 before and after collision was needed because position is not a constant of the motion. Specifically, X_c was inferred from the initial conditions and the measured momentum and time of particle 2. The time measurement necessitated using a current density in the subspace of particle 2. (TSS) (Disser. Abst.)

33586 INVESTIGATION OF THE PHYSICAL ROLE OF THE THEORY OF HYPERSURFACES IN THE GENERAL THEORY OF RELATIVITY. York, James Wesley Jr. Raleigh, N. C., North Carolina State, 1966. 121p.

Thesis.

The theory of hypersurfaces embedded in space–time is intimately related to a wide class of problems of the general theory of relativity, including important aspects of the fundamental structure of the field equations of this theory. For the most part, the hypersurfaces considered in this work are three dimensional and spacelike. Particular importance is attached to synchronous frames which, by definition, are comoving and time orthogonal. Spatial distance, spatial geometry, and time intervals are discussed in the context of hypersurface theory. In particular, the spatial metric is given by the coefficients of the first fundamental form of the hypersurface orthogonal to the timelike geodesic paths of space–time. The fundamental role of both the intrinsic and extrinsic geometric properties of hypersurfaces is considered. For example, it is found that the vanishing of the coefficients of the second fundamental form is equivalent to Rosen's covariant formulation of the Born rigidity criterion. These conditions, in turn, are related to a generalized process of "deformation" which is characterized by variational operators. A concise summary of the various interpretations of Born rigidity is given. The fundamental role of the Gauss–Codazzi equations of hypersurface theory is stressed. These integrability conditions on the embedding of hypersurfaces are useful in studying the structure of Einstein's gravitational field equations in terms of the associated Cauchy problem. In particular, the compatibility of the Cauchy data on an initial spacelike hypersurface and the subsequent compatibility of these data as the initial hypersurface develops in time are consequences of the Gauss–Codazzi equations together with a third fundamental set of hypersurface equations which are developed in this work. To further exploit the role of the theory of hypersurfaces in general relativity, the geometry of null hypersurfaces is briefly considered. Methods whereby the geometry of null hypersurfaces can be interpreted in any physically well defined reference system are indicated. Also, brief consideration is given to the relation of spatial geometry and matter–energy distributions. The properties of the Gauss–Codazzi equations and the third set of hypersurface equations mentioned above are discussed in the case of synchronous frames. It is found that to a considerable degree matter–energy distributions can be meaningfully characterized in terms of the spatial geometry of the synchronous frame. Several specific space–times are discussed in some detail, including two examples of cylindrically symmetric space–times that have been interpreted as rotating matter distributions. A classification scheme for comoving time-orthogonal and nontime-orthogonal frames based on the presence or absence of intrinsic rotation is given. (Disser. Abstr.)

33587 SINGULARITIES IN GENERAL PERTURBATIONS. Pierce, David Allen. New Haven, Yale Univ., 1966. 94p.

Thesis.

An analytic solution, in the form of a trigonometric series, is developed for the motion of a particle of negligible mass moving in the gravitational field of two massive primaries. The model of the planar, circular restricted problem of three bodies is used, and the Levi–Civita regularizing transformation is applied to the equations of motion in order to remove the singularity at one primary. The method of general perturbations is used to solve the transformed equations of motion, and first-order approximations to the regularized coordinates are expressed as trigonometric series in the regularized time. Series expressions for the transformed velocities may be obtained by differentiating the series for the coordinates. The solution for the motion of the massless particle is valid everywhere in the neighborhood of the primary and is nonsingular at the primary. Four numerical examples (two near-circular and two near-rectilinear orbits) are presented to show the precision with which the theory represents the motion of the particle during a few hundred revolutions. The long-term accuracy of the theory is discussed in a section dealing with the representation of the fundamental frequencies of the system. (TSS) (Disser. Abstr.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

Refer also to abstract 33963.

33588 UPPER LIMITS ON CROSS SECTIONS FOR $\gamma + n \rightarrow K^0 + \Lambda^0(\Sigma^0)$ BELOW 1500 MeV. Coyne, Donald G.; Mullins, Joe H. (California Inst. of Tech., Pasadena). Phys. Rev., 157: 1259-63 (May 25, 1967).

A search for the reactions $\gamma + n \rightarrow K^0 + \Lambda$ and $\gamma + n \rightarrow K^0 + \Sigma^0$ was conducted using the Cal Tech heavy-liquid bubble chamber as the detector with a central internal target. Photon energies were from threshold to 1530 MeV. The absence of any real events in 14,000 pictures implies a joint upper limit on the average total cross sections $\bar{\sigma}_\Lambda$ and $\bar{\sigma}_\Sigma$ in this energy region. If the ratio $\bar{\sigma}_\Lambda/\bar{\sigma}_\Sigma$ is near unity, it is found at the 90% confidence level: $\bar{\sigma}_\Lambda \leq 2.4\ \mu b$, $\bar{\sigma}_\Sigma \leq 2.1\ \mu b$. (auth)

33589 PHOTOPRODUCTION OF CHARGED PION PAIRS FROM HYDROGEN AT ENERGIES UP TO 1500 MeV. Fretwell, Lyman Jefferson Jr. Pasadena, Calif., California Inst. of Tech., 1967. 262p.

Thesis.

Charged pion pair photoproduction was investigated up to a gamma energy of 1500 MeV, using a heavy liquid bubble chamber with a small diameter, high-intensity photon beam passing through a central beam tube gaseous hydrogen target surrounded by the sensitive freon. Scanning, analysis, and data reduction techniques were developed to deal with the problems of two-view stereo, hidden event origins, absence of magnetic field, and the range-energy and multiple scattering relations that occur in the heavy materials. Roughly 5700 pictures were scanned and analyzed, yielding 754 acceptable events. Cross-section and parameter distributions are generally consistent with the results of previous experiments. A statistically insignificant "bump" was observed in the dipion mass spectrum in the region of 400 MeV, the disputed σ meson mass. This region was investigated as carefully as the limited statistics would allow; dipion angular distributions are consistent with isotropy, and there is indication that some of the events in this region might come from decay of an intermediate $N^*_{\frac{1}{2}}$ (1425) into a proton and dipion. (Disser. Abstr.)

33590 PHOTOPRODUCTION OF LEPTONS AND MESONS. Kitching, Peter. New Haven., Yale Univ., 1966. 227p.

Thesis.

An exploratory investigation of photon-induced interactions at GeV energies was made. The photoproduction cross sections for electrons, mesons (μ), (π), and (K) on hydrogen and carbon targets were observed. (TSS) (Disser. Abstr.)

Weak

Refer also to abstracts 32420, 33840, and 33878.

33591 (CERN-67-12) HIGH-ENERGY NEUTRINO INTERACTIONS. Young, Enoch C. M. (European Organization for Nuclear Research, Geneva (Switzerland)). Apr. 21, 1967. 127p. Dep.

Experimental studies are reported of high-energy interactions carried out at CERN during 1963-65, using the CERN heavy-liquid bubble chamber filled with freon CF_3Br and the spark chamber. Three problems were investigated; namely, the elastic neutrino reactions, the hyperon production by antineutrinos, and the single pion production. A brief theoretical review on the weak interactions involving the neutrinos is first given. Following the description of the experimental arrangements, the methods by which the neutrino or the antineutrino events were analyzed are discussed. Two types of background are studied in detail; those due to neutron-induced interaction and those due to incoming charged particles. Discussions and interpretations of the experimental results are then presented. (L.B.S.)

33592 ON THE DECAYS $\Sigma^\pm \rightarrow \Lambda^0 + e^\pm + \nu$. Barash, N.; Day, T. B.; Glasser, R. G.; Kehoe, B.; Knop, R.; Sechi-Zorn, B.; Snow, G. A. (Univ. of Maryland, College Park). Contract AT(40-1)-2504. Phys. Rev. Lett., 19: 181-5(July 24, 1967). (ORO-2504-106).

There were 550,000 pictures of stopping K^- mesons in hydrogen scanned for the decays $\Sigma^\pm \rightarrow \Lambda + e^\pm + \nu$, and the $\Sigma^- \rightarrow \Lambda + e^- + \nu$/all Σ^- decays are found to be $(0.64 \pm 0.12) \times 10^{-4}$ and $\Sigma^+ \rightarrow \Lambda + e^+\nu$/all Σ^+ decays to be $(0.20 \pm 0.08) \times 10^{-4}$. The rate for $\Sigma^- \rightarrow \Lambda + e^- + \nu$ yields a value of $D = 0.76 \pm 0.07$, and $\alpha = D/(D + F) = 0.64 \pm 0.06$. The observed electron-neutrino angular correlation together with the lamba polarization determines the magnitude of the ratio of vector to axial-vector coupling for this decay to 0.31 ± 0.30, consistent with the hypothesis of conserved vector current, with the absence of second-class currents, and with time-reversal invariance. (auth)

33593 DECAY RATE AND SPECTRA IN $K^0_L \rightarrow \pi^+ + \pi^- + \pi^0$. Hopkins, H. W. K.; Bacon, T. C.; Eisler, F. R. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 19: 185-9(July 24, 1967).

In a study of 9629 decays of K^0_L, the branching ratio [$K^0_L \rightarrow \pi^+ + \pi^- + \pi^0/K^0_L \rightarrow$ all charged modes] was measured as 0.161 ± 0.005. These decays were selected from the data with a background from the K^0_L leptonic modes of approximately 17%, and the energy spectrum of the π^0 meson fitted to a decay matrix element of the form $M = 1 - (a_0/M^2_\pi)(S_3 - S_0)$. The best fit value of the parameter a_0 was -0.249 ± 0.018. (auth)

33594 MEASUREMENT OF THE RELATIVE PARTIAL DECAY RATES FOR $K^\pm \rightarrow \pi^\pm + \pi^+ + \pi^-$. Fletcher, C. R.; Beier, E. W.; Edwards, R. T.; Hassenzahl, W. V.; Herzo, D.; Koester, L. J. Jr.; Mencuccini, C.; Wattenberg, A. (Univ. of Illinois, Urbana). Phys. Rev. Lett., 19: 98-101(July 10, 1967). (COO-1195-93).

The possibility of a violation of CP invariance in the charged $K \rightarrow 3\pi$ channel that is parity-conserving and strangeness-changing is investigated by measuring the relative partial rates of 3.5 GeV/c positive and negative kaons in the tau mode, $K^\pm \rightarrow \pi^\pm + \pi^+ + \pi^-$. Details are given of the detection apparatus and measurement. The value obtained after corrections was $\Gamma(--+)/\Gamma(++-) = 1.005 \pm 0.009$, thus showing no deviation from unity within experimental error. The result was found consistent with the following interpretations: (1) there is no CP-invariance violation in the relative rates due to the mechanism described; (2) there are no strong final-state pion interactions; and (3) there is a negligible I = 3 contribution to the tau matrix element. (L.B.S.)

33595 MEASUREMENT OF PION SPECTRA IN THE DECAY $K^0_2 \rightarrow \pi^+ + \pi^- + \pi^0$. Nefkens, B. M. K.; Abashian, A.; Abrams, R. J.; Carpenter, D. W.; Fisher, G. P.; Smith, J. H. (Univ. of Illinois, Urbana). Phys. Rev., 157: 1233-46(May 25, 1967). (COO-1195-84).

The pion spectra of the decay $K^0_2 \rightarrow \pi^+ + \pi^- + \pi^0$ are presented. Results are based on 1198 $K^0_{\pi 3}$ decays that were recorded with a spark chamber setup. $K^0_{\pi 3}$ is well described by a linear matrix element of the form $M \propto 1 + \sigma'_0[2T(\pi^0) - T(\pi^0)\max] m_+/m^2_\pi$ with $\sigma'_0 = -0.21 \pm 0.02$. There is no observable dependence of the matrix element on the X variable, $X \propto [T(\pi^+) - T(\pi^-)]$. Our measurement is in agreement with the $|\Delta I| = \frac{1}{2}$ rule. Various models to explain the observed variation of the density of the Dalitz plot are discussed. The value for the slope parameter is in good agreement with certain speculative predictions based on equal-time current commutators. No evidence for CP violation is found. (auth)

33596 COMPARISON OF π^+ AND π^- LIFETIMES. Ayres, David S.; Caldwell, David O.; Greenberg, Arthur J.; Kenney, Robert W.; Kurz, Richard J.; Stearns, Brenton F. (Univ. of California, Berkeley). Contract W-7405-eng-46. Phys. Rev., 157: 1288-92(May 25, 1967). (UCRL-17193).

A check on CPT invariance was made by comparing the lifetimes of the charged pion and its antipion. The fraction of surviving pions in beams of π^+ and π^- which were nearly identical in their spatial and momentum distributions were measured at ten positions along the beam using a liquid-hydrogen differential Čerenkov counter. Over 100 successive π^+-π^--π^+ comparisons were made. Because of the method used, many possible systematic errors which affect an absolute lifetime measurement cancel out in determining the ratio of the lifetimes. The ratio measurement gave $(\tau_+/\tau_-) - 1 = 0.0056 \pm 0.0028$ and the absolute π^+ lifetime was found to be 26.6 ± 0.2 nsec. (auth)

33597 OBSERVATION OF INTERFERENCE BETWEEN $\pi^+\pi^-$ AMPLITUDES FROM K_L DECAY AND COHERENT REGENERATION. Russ, James Stewart. Princeton, N. J., Princeton Univ., 1966. 91p.

Thesis.

A spark chamber–magnetic spectrometer search for interference between $\pi^+\pi^-$ decay amplitudes produced in free K_L decay, in apparent violation of CP invariance in the weak interactions, and from coherent regeneration was performed. Using diffuse beryllium regenerators of different mean densities evidence was

found for maximal constructive interference, independent of the K_S–K_L mass difference. Additional data using a solid beryllium regenerator provide good evidence that the magnitude of the mass difference lies in the interval $0.4 < \delta < 0.7$ in units of $\hbar/\tau_S$. Data were also taken on regeneration in liquid hydrogen and can be understood on the basis of large constructive interference with no anomalous effects. Optical model calculations of the phase of the regeneration scattering amplitude $f_{21}(0)$ in beryllium indicate it is largely imaginary, so that the dominant contributions to CP violation are expected to come from the mass matrix and/or $\Delta I = \frac{3}{2}$ currents. Implications of interference for CP conserving models are discussed. (Disser. Abstr.)

Strong (Baryon-Induced)

Refer also to abstract 33806.

33598 (ORO-2504-103) LOW ENERGY (Σ^+,p) AND (Σ^-,p) ELASTIC SCATTERING. Technical Report No. 655. Rubin, H. A. (Maryland Univ., College Park. Dept. of Physics and Astronomy); Burnstein, R. A. (Illinois Inst. of Tech., Chicago). Feb. 1967. Contract AT(40-1)-2540. 31p. Dep. CFSTI.

Thesis. Submitted by H. A. Rubin to Univ. of Maryland, College Park.

The cross sections for the elastic scattering of Σ^+ and Σ^- hyperons on protons were measured. The hyperons were produced by the interactions of stopping K^- mesons in a hydrogen bubble chamber. The cross section for (Σ^-,p) elastic scattering is 166 ± 33 mb, at a mean laboratory momentum of 150 MeV/c. The cross section for (Σ^+,p) elastic scattering is 84 ± 34 mb at a mean laboratory momentum of 161.5 MeV/c. These measurements, as well as the results of similar experiments, are compared with several recent theoretical predictions of hyperon nucleon scattering cross sections. (auth)

33599 (RHEL/R-144, pp 15-40) HIGH ENERGY PHYSICS DIVISION. (Rutherford High Energy Lab., Chilton (England)).

Experiments using electronic techniques and those using bubble chamber are briefly described. These experiments include proton–proton, meson (K)–proton, and meson (K)–deuteron interactions, and various meson decays. Counter and spark chamber electronics are also mentioned. (J.F.P.)

33600 PROTON AND PION SPECTRA FROM PROTON–PROTON INTERACTIONS AT 10, 20, AND 30 GeV/c. Anderson, E. W. (Brookhaven National Lab., Upton, N. Y.); Bieser, E. J.; Collins, G. B.; (and others). Contract AT(30-2)-Gen-16. Phys. Rev. Lett., 19: 198-201(July 24, 1967). (BNL-11228).

The secondary proton and pion spectra from proton-proton interactions have been measured over nearly the entire momentum range and over a wide range of laboratory angles. Most of the data are at an incident-proton momentum of 30 BeV/c. The proton spectra were transformed into cross sections in terms of $p_\perp^*$ and $p_{||}^*$ all in the cm system. These cross sections were found to be largely independent of $p_{||}^*$ and an empirical fit was obtained quite similar to one derived by Hagedorn using a statistical model. The pion spectra were also expressed in terms of $p_\perp^*$ and $p_{||}^*$ and found to be different from the proton spectra by showing a marked dependence on $p_{||}^*$. (auth)

33601 PROTON–PROTON BREMSSTRAHLUNG AT 204 MeV WITH A POLARIZED BEAM. Rothe, K. W.; Koehler, P. F. M.; Thorndike, E. H. (Univ. of Rochester, N. Y.). Phys. Rev., 157: 1247-58(May 25, 1967).

A proton-proton bremsstrahlung experiment was completed using 204-MeV, 90% polarized protons incident on a liquid-hydrogen target. The gamma ray was detected in a threshold counter. The two protons were observed in a spark-chamber array giving energy and direction information. Cross sections and gamma ray and proton asymmetries due to the polarized beam were measured. The cross sections obtained agree with the theoretical calculations of Sobel and Cromer, and Duck and Pearce. Ueda's calculation is high by a factor near 2, but properly describes the shape of $(d^2\sigma/d\Omega_\gamma dE_\gamma)$ versus E_γ. Proton asymmetries agree in sign and magnitude with the elastic 210-MeV values. Gamma-ray asymmetries are of the same sign and magnitude as those obtained in our measurements of $p + n \rightarrow d + \gamma$ which agree with photodisintegration calculations. An upper limit of 35 nb was placed on the production of $p + p \rightarrow p + p^*$ ($p^* \rightarrow p + \gamma$) decaying to a gamma and a proton for lifetimes $10^{-12} \leq \tau \leq 10^{-10}$ sec. (auth)

33602 STUDY OF HYPERFRAGMENTS. PART V. ANALYSIS OF LIGHT HYPERFRAGMENTS. Chaudhari, K. N.; Ganguli, S. N.; Rao, N. K.; Swami, M. S. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 65: 240-55 (Apr. 1967).

There were 464 nonmesic and 65 mesic decay of hyperfragments (HFs) produced by pions of momenta 3.5 GeV/c and 17.2 GeV/c and protons of momentum 23 GeV/c, which were used to obtain information of Q^-, the ratio of nonmesic to π^- mesic events and S, the ratio of neutron to proton stimulated events as a function of charge of HFs. It is found that Q^- increases rapidly with the increase in charge of HFs; the value of Q^- for HFs of $Z \geq 3$ is 14.6 ± 3.0 which is high compared to the theoretical value of about 4 to 5. The value of S is found to be > 1 for all HFs of $Z \geq 2$. (auth)

33603 SEARCH FOR RESONANCES IN A SYSTEM OF TWO BARYONS WITH $s = -1$ AND $s = 0$. Vishnevskii, V. F.; Moroz, V. I.; Shakhbazyan, B. A. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 5: 252-5 (May 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 307-10(May 1, 1967).

An investigation is made of the mass spectrum of dibaryon states of the systems Λp and pp, obtained by reducing the photographic data from the propane bubble chamber irradiated by neutrons having kinetic energies up to 10 GeV. Preliminary results are presented. The effective mass spectrum of the Λp system, obtained from single- and three-prong events on free protons is shown. No singularities were observed in the experiment in the pp-system mass spectrum from three- and five-prong events without strange particles. (J.F.P.)

33604 MEASUREMENT OF PROTON POLARIZATION IN ELASTIC SCATTERING BY OXYGEN. Pucherov, N. N.; Soroka, V. I. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 479-81(Mar. 1967). (In Russian).

The excitation function of proton polarization at 2 to 3 MeV energy and laboratory 60° angle was measured and the angular distribution of polarization of 2.5-MeV protons at 45 to 110° angles was found by the method of double scattering of protons on gas targets. Tabulated data are given on elastic scattering polarization by oxygen at $\theta = 60°$ and the angular distribution of elastic scattering polarization by oxygen at 2.5 MeV. (R.V.J.)

33605 THE POLARIZATION PARAMETER IN ELASTIC PROTON–PROTON SCATTERING FROM 0.75 TO 2.84 GeV. Neal, Homer Alfred Jr. Ann Arbor, Univ. of Michigan, 1966. 118p.

Thesis.

A double-scattering technique was employed to measure the polarization parameter in elastic proton–proton scattering at .75, 1.03, 1.32, 1.63, 2.24 and 2.84 GeV. An external proton beam from the Cosmotron was focussed on a three-inch-long liquid hydrogen target, and the elastic recoil and scattered protons were detected in coincidence by scintillation counters. The polarization produced in the scattering process was inferred from the azimuthal asymmetry exhibited in the scattering of the recoil beam from a carbon target. This asymmetry was measured by a set of two scintillation counter telescopes which symmetrically viewed the carbon target. The corrected values of the polarization parameter are exhibited as a function of the center-of-mass scattering angle for each incident beam energy. The prediction of the Regge theory that the polarization parameter in elastic proton–proton scattering is related to the total p-p and p-$\bar{p}$ cross sections was found to be consistent with the experimental results. (TSS) (Disser. Abstr.)

33606 SEARCH FOR ANTIPROTONS AND STUDY OF PARTICLE PRODUCTION IN 3-BeV PROTON–NUCLEUS COLLISIONS. Smith, Arthur John Stewart. Princeton, N. J., Princeton Univ., 1966. 134p.

Thesis.

In two counter experiments at the accelerator, a study was made of 2.9 BeV proton-nucleus collisions. In the first experiment, differential cross sections were measured as a function of momentum for the production of $\pi^\pm$ mesons, K^+ mesons, protons, deuterons, tritons, and helium-3 by 2.9 BeV protons striking beryllium and platinum targets. The Be data were taken at laboratory angles of 13°, 30°, 60°, and 93° relative to the direction of the incident proton beam; the Pt data, at 13° and 93° only. An analysis of these cross sections is given in terms of models of proton-nucleus interactions. The copious production of deuterons and tritons at all angles is found to be a complex nuclear effect. In a second experiment, antiproton production was observed in 2.88- and 3.05-BeV proton-copper collisions, at a laboratory angle of 13° and at a momentum of 760 MeV/c. The cross section for this antiproton production is presented, and used to estimate the distribution of Fermi momenta of the nucleons in the copper nucleus. (Disser. Abstr.)

33607 STRANGE-PARTICLE PRODUCTION IN 8 GeV/c PROTON–PROTON INTERACTIONS. Firebaugh, Morris William. Urbana, Ill., Univ. of Illinois, 1966. 200p.

Thesis.

An experiment was performed in which 37,000 pictures were obtained of the hydrogen bubble chamber exposed to 8 BeV/c protons. All 2-, 4-, 6-, and 8-prong events with one or more associated kinks or V's were scanned for and 7,300 candidates for strange particle events were found. Of these, 3,600 were successfully measured and, of these, 1,260 strange particle events were identified. A fiducial region was selected and the partial cross section for 33 different final states calculated. This corresponds to a corrected cross section for identified strange particle events of 950 ± 95 μb. The total strange particle production cross section is estimated to be 1.8 mb. Evidence for N*(1236), Y_1^*(1385), Y_0^*(1405), and Y_1^*(1660) formation is presented. Data concerning the existence of reported di-baryon resonances in the AN final state is presented, and the conclusion is drawn that no such resonances appear in the AN and ΣN mass distributions of this experiment. Finally, the 3 body final states are examined in detail. An anomalous peaking is observed in the $K^+\Lambda$ invariant mass in the $K^+P\Lambda$ final state. The simple one pion exchange model does not seem to predict adequately the distribution observed. The OPEM also predicts a cross section for this final state a factor of 2 larger than the measured value of 54 ± 7 μb if no cutoff in 4-momentum transfer to the proton is imposed. (Disser. Abstr.)

33608 HYPERON PRODUCTION IN 7 GeV/c $\bar{P}$-P INTERACTIONS. Chien, Chih-yung. New Haven, Yale Univ., 1966. 189p.

Thesis.

Hyperon and antihyperon production in the collisions of 6.94 BeV/c antiprotons with protons was studied. The antiproton-proton reactions were obtained by introducing the separated antiproton beam into the 80'' liquid hydrogen bubble chamber. 80,000 pictures were taken, giving a total antiproton path of 0.54×10^6 m in liquid hydrogen. All the events involving hyperon and/or antihyperon production were studied and their total cross section is 1.3 ± 0.1 mb. Compared with results from experiments at lower beam momenta, the cross section for two-body hyperon production has decreased to 0.1 mb while those for three- and four-body productions have increased appreciably in this experiment. All the events of two-, three-, and four-body final states were produced highly peripherally and the results from these states are in good agreement with the single particle exchange hypothesis, Y_1^* (1385) was by far the most prominent resonance produced, and production of Y_0^* (1405), Y_0^* (1520), and Y_1^* (1765) was also observed. A thorough search was also made for Ω^- and $\overline{\Omega^-}$ particles, but no event was found to be consistent with their production and decay. (Disser. Abstr.)

Strong (Meson-Induced)

33609 (AD-637734) STUDY OF PI (+) 2 PI (-) FINAL STATES COHERENTLY PRODUCED ON NUCLEI BY 16 GeV/c PI (-). Final Technical Report. Allard, J. F.; Drijard, D.; Hennessy, J.; Huson, R.; Lloret, A. (California Univ., Berkeley. Cosmic Ray Group). Aug. 1966. Contract Nonr-3656(13). 25p. (ONR-2-1966). CFSTI.

Coherent production of $\pi^+2\pi^-$ occurs in approximately 1% of 15 and 16 GeV/c π^- C_2F_5Cl interactions. For nearly every coherent event, one or both $\pi^+\pi^-$ combinations lie in the ρ^0 or f^0. The ratio of π^-f^0 to $\pi^-\rho^0$ coherent production is 0.05 plus or minus 0.02. No N^* peaks are seen in the coherent events. S-wave $\pi^-\rho^0(J^P = 1^+)$ dominates up to at least 1.2 GeV in M $\pi^-\rho^0$ but small admixture of waves opposite parity is necessary to explain some angular distribution asymmetries. The Dalitz plot excludes dominance of triangle singularity effects. The $\pi^-\rho^0$ mass distribution is dominated by a peak in the A_1 region, nearly 250 MeV wide, but too narrow to be explained by the momentum transfer limitation imposed by the nuclear form factor. The calculated OPE (Deck model) and ρ exchange $M_{\pi\rho}$ distributions are also too broad to fit the data, but uncertainties in the model preclude its firm rejection. If $M_{\pi\rho}$ distribution is assumed due entirely to resonances, there must be one dominant $J^P = 1^+$ resonance near 1.05 GeV. To preserve the A_1 with width <150 MeV one must assume two other resonances (940 and 1180 MeV) in addition to the A_2(1315). (auth) (TAB)

33610 (JINR-P1-3351) ZAMECHANIYA O(Λη)*-REZONANSE. (Some Notes on (Λη)*-Resonance). Volod'ko, A. G.; Vinogradov, V. B.; Klimenko, S. V.; Lomakin, Yu. F.; Patochka, I.; Flyagin, V. B.; Shlyapnikov, G. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 23p. (In Russian). Dep.

Two bubble chamber experiments were performed to study the effective mass spectrum of Λγ combinations. It was concluded that the (1300-1400) MeV bump of the spectrum testifies to the existence of 1680 MeV $Y^* \rightarrow \Lambda\eta$ resonances. Indeed, no resonance is known to produce such a narrow bump on the mass spectrum in the (1300-1400) MeV region. The aim of this investigation is an attempt to quantitatively appreciate the effect. Such estimates can be done by comparing the experimental effect-background relation and the effect-background one within the best suggestion for the $(\Lambda\eta)^*$-existence. It is suggested that the 1680-MeV resonance does exist. The results of present calculations can be reported as follows: If the Y^*_{1680} decays into Λη and Σπ are taken into account and $[W(Y \rightarrow \Sigma^0_\gamma\gamma)]/[W(Y \rightarrow \Lambda\eta)] = 3.5$, the Y^* production cross section is $\sigma_Y < 0$!, the suggestion is wrong. If, on the other hand, the Σπ decay mode is forbidden (the known quantum numbers do not allow one to obtain it), $\sigma_Y = (330^{+100}_{-80})\mu b$. This is larger than the greatest value $\sigma_{\Sigma\pi}^{max} = 200$ μb from the experimental cross section results. Therefore, one arrives at a conclusion that it is impossible to explain the (1300-1400) MeV bump only by $Y^* \rightarrow \Lambda\eta$ existence. The resonance $Y \rightarrow \Lambda\gamma$ (M = 1350) MeV might exist, in principle, though there are some difficulties as well. The main one is the width of the experimental bump. It should be also noted that there have been no publications which proved $(\Lambda\eta)^*$-resonance existence in a unique way. (auth)

33611 CORRELATED PROTON PAIRS IN A HIGH ENERGY NUCLEAR REACTION. Siemiarczuk, T.; Zielinski, P. (Univ., Warsaw. Inst. of Nuclear Research, Warsaw). Phys. Lett., 24B: 675-6(June 26, 1967).

Emission of correlated proton pairs in 780 interactions of 9 GeV negative pions with xenon nuclei was observed. An order of magnitude of several per cent was found for the fraction of protons emitted as correlated pairs. (J.F.P.)

33612 CROSS SECTION FOR THE REACTION $\pi^- + p \rightarrow n +$ NEUTRAL PARTICLES FOR PIONS IN THE MOMENTUM RANGE 0.78 TO 5.3 GeV/c. Feldman, M. (Univ. of Pennsylvania, Philadelphia); Frati, W.; Halpern, J.; Kanofsky, A.; Nussbaum, M.; Richert, S.; Yamin, P.; Choudry, A.; Devons, S.; Grunhaus, J. Contract (30-1)-2171; 30-1-1932. Nuovo Cim. (10), 50A: 89-94 (July 1, 1967).

The cross section was measured for the reaction $\pi^- + p$ yielding neutral final states in momentum range of (784 to 5290) MeV/c of the incident pion. A table of cross sections corrected for nonstrange processes is presented and a discussion of the 1688, 1920, and 2190 MeV resonances is included. (auth)

33613 EXPERIMENTAL RESULTS ON 8 GeV/c π^--p INTERACTIONS WITH TWO, THREE AND FOUR PIONS. Allard, J. F. (Faculte des Sciences, Orsay, France); Hennessy, J.; Huson, R.; (and others). Nuovo Cim. (10), 50A: 106-19(July 1, 1967).

π^--p interactions at 8 GeV/c were produced in a liquid-hydrogen target placed in 1 m heavy liquid bubble chamber of the Ecole Polytechnique. The following resonances were observed: $N^{*++}_{3/3}$ and ρ^0 in the $\pi^+\pi^-\pi^-p$ channel, a small proportion of ω^0 in the $\pi^+\pi^-\pi^0$n channel, and ρ^0 in the $\pi^+\pi^-\pi^+\pi^-$n channel. In particular in three-charged-pion production, there is no evidence for A_1 and A_2 states and quasi-two-body final states are very rare. The Deck-model predictions, without nuclear absorption and ρ-ρ symmetrization, are in fair agreement with $\pi^+\pi^-\pi^-$ mass and Δ^2 experimental distributions; however the angular predictions do not fit the data well. The total and differential cross sections are given for each channel; for all reactions, the 4-momentum transfer distribution shows a slope comparable to that for elastic scattering. (auth)

33614 INELASTIC π^-p-INTERACTIONS AT 7.5 GeV. FOUR-PRONG EVENTS WITH NEUTRONS. Belyakov, V. A.; Kladnitskaya, E. N.; Kuznetsova, E. S.; Balya, E.; Balya, O.; Mikhul, A.; Sabeu, M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 1232-8(June 1967). (In Russian).

A study was made of 524 events of the reaction $\pi^-p \rightarrow n\pi^+\pi^+\pi^-\pi^- + m\pi^0$ detected by means of the JINR 24-liter propane bubble chamber exposed with 7.5-GeV mesons. The cross section for the studied reaction is found to be 3.7 ± 0.2 mb. The angular and momentum distributions of secondary π^+- and π^--mesons were investigated in the c.m. system. The correlation takes place between transverse and longitudinal moments of the particles in the c.m.s. The production of the nucleon isobars and resonance states decaying into charged π-mesons were studied. ρ^0-meson production was observed, which is more pronounced in the reaction without π^0-mesons. Some evidence of A_1- and A_2-mesons is indicated. The maxima in the four-pion effective-mass spectra in the regions 1.2 to 1.4 and 1.5 to 1.7 GeV were also observed. These maxima are either due to 4π resonance production or to the resonances including π^0-mesons. The N^*_{33}-isobar production was observed in reactions without π^0-mesons. (auth)

33615 INVESTIGATION OF THE REACTION $\pi^- + p \rightarrow \pi^- + \pi^+ +$ n AT 1.3 GeV/c IN ORDER TO OBTAIN THE PION-PION INTERACTION CROSS SECTION. Aref'ev, A. V.; Bayukov, Yu. D.; Efremenko, V. I.; Zaitsev, Yu. M.; Kozodaev, M. S.; Kuleshov, V. A.; Leksin, G. A.; Osipenkov, V. T.; Suchkov, D. A.; Fedorov, V. B.

(Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 5: 1239(June 1967). (In Russian).

The $d^2\sigma/dp^2d\omega^2$ for the reaction $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ are measured at $p = 1.3$ GeV/c in the region $4.2 \leq \omega^2 \leq 9.2$ and $0.1 < p^2 < 8$. The present data show the dominant contribution from one-meson exchange. The pion-pion elastic scattering cross sections in the physical region were obtained by extrapolation. (auth)

33616 PROTON POLARIZATION IN K^+p ELASTIC SCATTERING AT 780 MeV/c. Femino, S. (Univ., Messina, Italy. Istituto Nazionale di Fisica Nucleare, Sicily, Italy); Jannelli, S.; Mezzanares, F.; Monari, L.; Serra, P. Nuovo Cim. (10), 50A: 371-3(July 21, 1967).

The results are presented of a bubble-chamber experiment on the polarization of the recoil proton in K^+p elastic scattering at 780 MeV/c. 120,000 pictures were scanned for events of the type $K^+ + p \rightarrow K^+ + p$ with a subsequent pp scattering, and 400 were identified. The experimental results are in agreement with the polarization predicted from the accepted set of phase shifts for K^+p elastic scattering in this energy region. (L.B.S.)

33617 CASCADE MODEL ANALYSIS OF THE INTERACTIONS OF 17.2 GeV MESONS WITH HEAVY EMULSION NUCLEI. Kohli, J. M.; Mittra, I. S.; Singh, M. B. (Punjab Univ., Chandigarh, India). Nucl. Phys., B2: 164-6(1967).

The comparison of the theoretical results obtained on the basis of internuclear cascade initiated in AgBr nuclei by 17-GeV mesons with the experimental results shows that the theoretical results are in good agreement only with events having $N_h \geq 8$ but not with an overall sample of AgBr events. (auth)

33618 SINGLE AND MULTIPLE PION PRODUCTION IN π^+n AND π^-p INTERACTIONS AT 1.7 GeV/c. Bacon, T. C.; Fickinger, W. J.; Hill, D. G.; Hopkins, H. W. K.; Robinson, D. K.; Salant, E. O. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 157: 1263-78(May 25, 1967). (BNL-10885).

Meson production in π^-p and π^+n interactions at 1.7 GeV/c was studied in two bubble-chamber exposures. Combined results are presented with emphasis on single-pion production (4300 events) which is dominated by the formation of the ρ^0 meson in peripheral interactions, and on double-pion production (1100 events) which shows strong formation of the ω meson. These data are compared with the predictions of particle-exchange models, including absorption, and the effects of competing channels are discussed. Evidence for a two-pion decay mode of the ω is examined quantitatively. Processes with higher meson multiplicities are described. (auth)

33619 PRODUCTION PROCESSES AND DECAY MODES OF THE ϕ MESON. Lindsey, James Seward. Berkeley, Calif., Univ. of California, 1966. 73p.

Thesis.

The reaction $K^-p \rightarrow \Lambda\phi$ was studied in an exposure of the 72-inch bubble chamber to a separated beam of K^- mesons of 2.1 to 2.7 BeV/c momentum. The decay branching ratios for K^+K^-, $K_1^0K_2^0$, $\rho\pi$, $\eta\gamma$, $\pi^+\pi^-$, $\rho\gamma$, and $\omega\gamma$ were measured, and the ratio $\beta = [\Gamma(\phi \rightarrow K_1^0K_2^0)/\Gamma(\phi \rightarrow K^+K^-)]$ was used as a test of the ϕ's spin. The quantum numbers assigned to the ϕ, $J^{PC} = 1^{--}$ and $I = 0$, were verified. An attempt was made to fit decay-angular distributions to several models, in order to further confirm the spin-1 assignment for the ϕ. However, the distributions are consistent with predictions for both spin-1 and spin-3, so that no independent test of spin is possible. Production processes were investigated with the correlation-matrix method of Berman and Oakes. The low-momentum (2.1 BeV/c beam momentum) data fit a model of K and K* exchange, but the high-momentum (2.45 to 2.7 BeV/c) data are inconsistent with the model. Also, other final states involving $K\bar{K}$ pairs were investigated, and their cross sections measured, but except for the production of the reaction $K^-p \rightarrow Y_1^*(1385)\phi$, no previously unreported effects were observed. (Disser. Abstr.)

33620 A STUDY OF THE REACTION $\pi^- + p \rightarrow$ NEUTRALS AT 895 MeV. Panvini, Robert S. Waltham, Mass., Brandeis Univ., 1966. 100p.

Thesis.

A study of the interaction $\pi^- + p \rightarrow$ neutrals for incident π^- kinetic energy of 895 MeV is made. The processes with neutral final states which occur with appreciable cross sections at this energy are listed. The partial cross sections and total cross sections for these interactions are given. The charge exchange differential cross section is also given for the interaction $\pi^- + p \rightarrow n + \pi^0$. (TSS) (Disser. Abstr.)

33621 K^--PROTON INTERACTIONS NEAR 760 MeV/c. Bastien, Pierre Lucien. Berkeley, Calif., Univ. of California, 1966. 77p.

Thesis.

The interactions of K^- mesons with hydrogen, at beam momenta of 620, 760, and 850 MeV/c, were studied in the 15-inch hydrogen bubble chamber. The cross sections for all the reactions allowed at these momenta were measured, together with the angular distributions for the two-body final states. The energy dependence of these cross sections shows that, at 760 MeV/c, they are affected by a recently discovered resonant state, Y_1^* (1660). On the basis of an analysis of the cross sections, a spin assignment of 1/2 for Y_1^* (1660) is ruled out. A spin assignment of 3/2 seems to be more consistent with the data than higher spin values because of the absence of large $\cos^3\theta$ terms in the angular distributions at 760 MeV/c. (Disser. Abstr.)

33622 K^* RESONANCE PRODUCTION IN K^-d INTERACTIONS AT 2.24 BeV/c. DeRemer, Russell Jay. Bloomington, Ind., Indiana Univ., 1966. 78p.

Thesis.

As part of a study of K^-d interactions at 2.24 BeV/c, some important final states that might involve K^* (891) production were examined. The experiment was performed on the Alternating Gradient Synchrotron and the exposures made in the bubble chamber filled with liquid deuterium. The only final state examined that involves a significant amount of K^* meson production is $p\pi^-\bar{K}^0n$. The analysis of this reaction comprises the bulk of the work; the results of the investigation of other final states are mentioned. Based on the impulse model, the $K^-d \rightarrow p\pi^-\bar{K}^0n$ events can be separated into K^-p and K^-n interactions. The corrected cross sections for these channels are 1.29 ± .21 mb. and 2.34 ± .32 mb. respectively. The K^* (891) meson is prominent in each reaction and is seen in about 40% of all of the events. There is little evidence for deuterons in the final state and, therefore, no significant amount of coherent production of the K^*. As has been found in other experiments, the K^-p data are consistent with no other resonance production. The K^-n data, however, exhibit some N^* (1238) production as well. There is no other data presently available with which to compare this finding. The main feature of the K^* production is its high degree of peripherality in the overall center of mass system; this feature is characteristic of experiments involving K^* production at high energies and is indicative of a single-particle exchange mechanism. The simple peripheral model of Gottfried and Jackson can be applied to the K^* decay correlations to obtain an indication of what type particle exchange is responsible for the production. A compilation of results of the application of the simple peripheral model to decay correlations indicates a trend from pseudoscalar meson exchange, for incident K momenta of about 1.5 BeV/c, to vector meson exchange, for incident K momenta of about 3.0 BeV/c. The beam momentum of 2.24 BeV/c in this experiment is an intermediate momentum; this is reflected by the presence of significant contributions to the exchange from both pseudoscalar and vector mesons. The simple peripheral model applied to the data yields a vector to pseudoscalar ratio of 1.3. (Disser. Abstr.)

33623 A STUDY OF THE $K^- + p \rightarrow \bar{K} + N + \pi$ REACTIONS AT 1.33 GeV/c. Ficenec, John Robert. Urbana, Ill., Univ. of Illinois, 1966. 131p.

Thesis.

An experiment was performed on K^- meson-proton interactions using the liquid hydrogen bubble chamber. As part of that experiment the following topologies were investigated: 2-prong, 2-prong with 1 kink, and 0-prong with an associated vee. In particular, the reactions $K^- + p \rightarrow \bar{K} + N + \pi$ are reported. A sample of 30,000 frames containing 11,111 2-prong events was used, with measurements being done on SMP's. These reactions are found to be dominated by $\bar{K}^*(890)N$ production. Some evidence is also found for $N^*(1236)\bar{K}$ and $Y_0^*(1520)\pi^0$ production, and slight amounts of $Y_1^*(1660)\pi$ and $Y_1^*(1765)\pi$ are seen. A backward peaking is seen to exist in the production angular distribution of the $\bar{K}^{*-}(\bar{K}^0\pi^-)$. No evidence for this backward peaking is found in the other $\bar{K}N\pi$ final states. The production and decay angular distributions of the $\bar{K}^*(890)$ indicate that the $\bar{K}^{*0}n$ final state is produced predominantly by an exchange of a pseudoscalar meson of small mass, probably the pion. The $\bar{K}^{*-}p$ final states show less marked evidence for peripheral production than does the $\bar{K}^{*0}n$ final state. If the one-particle exchange model is hypothesized as a contributing mechanism, the $\bar{K}^{*-}p$ final states appear to have a large amount of T = 0 vector meson exchange contributing to their production. This could be either the ω or φ meson. (Disser. Abstr.)

33624 PION–PION INTERACTIONS FROM π^-p COLLISIONS AT 3 AND 4 GeV/c. Noble, Carl Marcus Jr. Berkeley, Calif., Univ. of California, 1966. 132p.

Thesis.

The final state $\pi-\pi$ interaction in the process $\pi^- + p \rightarrow \pi^+\pi^-n$ was studied at incident momenta of 3 and 4 BeV/c by means of a magnetic spectrometer using spark chambers. A lead "sandwich" counter system surrounding part of the hydrogen target

rejected events of higher multiplicity to enhance detection of the $\pi^+\pi^-n$ final state. The system, biased for low four-momentum transfer (Δ^2) acceptance, recorded 879 and 1248 $\Delta^2 < 9\ \mu^2$ events at 3 and 4 BeV/c respectively. The energy of the ρ peak in the di-pion mass spectrum depends on Δ^2, $\theta_{\pi\pi}$ (the $\pi-\pi$ scattering angle), and φ_{TY} (the Treiman-Yang angle). This dependence indicates that processes other than one-pion-exchange are important. The absorptive theory as proposed by Durand and Chiu (which includes an I = 0, J = 0 particle, the ϵ^0) qualitatively explains the ρ decay distribution (cos $\theta_{\pi\pi}$ vs. φ_{TY}). Unfortunately the geometrical bias precludes quantitative comparison and the calculation of meaningful cross sections. In the ρ region, the forward to backward $\pi-\pi$ scattering ratio is ~.5 for $\Delta^2 < 3\ \mu^2$ and decreases with increasing Δ^2. No direct evidence is seen for the $\omega \rightarrow 2\pi$ decay. (Disser. Abstr.)

33625 A STUDY OF HYPERFRAGMENTS PRODUCED BY 2.3 GeV/c K^- INTERACTIONS IN EMULSION. **Prem, Ravinder Jit. College Park, Md., Univ. of Maryland, 1965. 113p.**

Thesis.

Studies of hyperfragments produced by 2.3–2.5 BeV/c K^- interactions in nuclear emulsion are reported. The observed features of production are discussed in view of proposed models. The large abundance of short-range hyperfragments ($R \leq 5\mu$) is satisfactorily explained in terms of the "spallation model." The longer range hyperfragments are a result of nuclear evaporation processes. Some evidence for the existence of "direct-production" or "prompt-emission" mechanism is found from the observation of forward-moving energetic light hyperfragments. The lifetimes of hydrogen and helium hypernuclei have been measured. They are found to be: $\tau({}_\Lambda H^3) = 0.9^{+2.2}_{-0.4} \times 10^{-10}$ sec., $\tau({}_\Lambda H^4) = 1.8^{+2.5}_{-0.7} \times 10^{-10}$ sec., and $\tau({}_\Lambda He^5) = 1.4^{+2.5}_{-0.5} \times 10^{-10}$ sec. Also one in-flight and nine at-rest decays of ${}_\Lambda He^4 \rightarrow He^3 + p + \pi^-$ are observed in an estimated time of 1.50×10^{-10} sec. The results are in agreement with the previous investigations, but with large statistical errors. These lifetimes are combined with similar experimental results and are then compared with the theoretical estimates. Also presented are the Λ particle binding energies from 43 uniquely identified mesic decays. The results are in good agreement with previously reported values. Based on the analysis of two short-range mesic hyperfragments, the Λ particle binding-energy-limit is found to be 22.1 MeV. This value is consistent with previously reported values and also with theoretical estimates. (Disser. Abstr.)

33626 AN ANALYSIS OF RHO MESON PRODUCTION AND DECAY IN π^--PROTON INTERACTIONS AT 2.26 GeV/c. Reynolds, Bruce Grahlmann. Gainesville, Fla., Florida State Univ., 1966. 194p.

Thesis.

A liquid hydrogen bubble chamber investigation of π^--proton interactions was carried out at a momentum of 2.26 BeV/c. A total of 9,228 two-prong events were measured and the partial cross sections for nonstrange final states were determined. The three-body final states are found to be dominated by ρ meson production. In any charge state, isobar production is very small. The production and decay of the ρ meson is analyzed in terms of the one-pion-exchange (OPE) model and in terms of the one-pion-exchange model modified to include absorption (OPEA). The elements of the ρ meson spin-space density matrix are measured and a discussion of the neutral ρ anomaly is given. (Disser. Abstr.)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 33066.

33627 HYPERFINE STRUCTURE OF THE MASS SPECTRUM OF ELEMENTARY PARTICLES. Akulov, N. S. Dokl. Akad. Nauk BSSR, 11: 209-13(Mar. 1967). (In Russian).

The mass spectrum of particles of prematter (reons), from which all particles are constructed, was examined. It was explained that neutral reons in any particle appear as quasi-particles (virtual neutrino) which after decay of the particle are converted into the observed ν. They have the mass $m_1 = m_0 - 2.5\ m_0$. Electrons and positrons can be considered as neutrinos with charge. In particles their mass is $m_2 = m_1 + 9m_0 = 28.334\ MeV/c^2$, where m_0 is the electron mass. The value $m_0 = 35.013$ was determined theoretically by use of the results obtained by Browne for the mass of the electron moving with ultrarelativistic velocity in positronium. The differences between the Nambu quantum m_0 and the standard 33.735 can be considered as the mass defect δ. The simple formula for the calculation of the mass spectrum was obtained: $m = n \cdot 35.013 + [9z - 2.5n - (z-2)\ |S|]0.511\ MeV/c^2$, where n is the number of preparticles (reons), from which z is the charge number, which for $\mu^\pm$, π^0, $\pi^\pm$, and especially $K^\pm$ and K^0 gives surprisingly accurate results. It was established that the size of the charge on the pion mass is different from its size in the kaon mass. The phenomenon is considered as evidence of the hyperfine structure of the mass spectrum. A formula was obtained which gives the possibility of quantitatively determining the size of this and establishing its connection with the strangeness of the particle ($|S| = 0.1$). (tr-auth)

33628 SPACE–TIME AND DEGREES OF FREEDOM OF THE ELEMENTARY PARTICLE. **Bacry, H. (Argonne National Lab., Ill. Inst. for Advanced Study, Princeton, N. J.). Commun. Math. Phys., 5: 97-105(1967).**

First, a general property of Lie groups is used in the case of the Poincaré group in order to define the one-particle phase space. It is eight-dimensional in the general case and six-dimensional for a spinless or massless particle. Embedding the Poincaré group into the similitude group of space-time permits an interpretation of the dilatation operator as a dynamical variable. The connection between the similitude group and field equations is discussed. Lurçat's ideas on a possible dynamical role of spin and mass-spin spectra of particles (Regge trajectories) are discussed under the point of view of the degrees of freedom. (auth)

33629 ON THE PHYSICAL INTERPRETATION OF MANIFEST COVARIANT REPRESENTATIONS OF THE INHOMOGENEOUS LORENTZ GROUP FOR ZERO MASS. **Langbein, Werner (Univ., Wuerzburg, Ger.). Commun. Math. Phys., 5: 73-87(1967). (In German).**

It is shown that the class of fields (a,b) involving a particle of zero rest mass and helicity h is restricted only by the condition $|a + b| \geq |h|$, $(a + b/h$ integer), if the representation space is not required to be irreducible. The main feature of the corresponding physical interpretation is the occurrence of gauge particles. The investigations are carried out in terms of manifest covariant representations of the inhomogeneous Lorentz Group, which are shown to be not fully reducible in the zero rest mass case. The results are also obtained by a limiting process $m \rightarrow 0$. (auth)

33630 ON EMBEDDING OF POINCARE ALGEBRA. Fushchich, V. I. (Inst. of Mathematics, Kiev). Ukr. Fiz. Zh., 12: 741-6(May 1967). (In Russian).

The way of constructing, according to a given spectrum of elementary and hypothetic particle masses, such an algebra G, containing Poincaré algebra P as a subalgebra, or an enveloping algebra U(P), that a mass operator determined in the space, where one of unreducible representations is given, be selfadjoint and have a spectrum, coinciding with the given mass spectrum. By embedding small Poincaré algebra (nonrelativistic case) an explicit type of a mass operator was obtained. It is noted that the mass operator can depend on a spin and parity only in the case when the fundamental particles, of which hadrons and bosons "consist," have different types and parity. (auth)

33631 EVALUATION OF PHASE-SPACE INTEGRALS. **Campbell, Graham H.; Lepore, Joseph V.; Riddell, Robert J. Jr. (Univ. of California, Berkeley). Contract W-7405-eng-48. J. Math. Phys. (N. Y.), 8: 687-91(Apr. 1967). (UCRL-16522).**

The relativistic phase-space integral over the submanifold defined by total momentum zero and fixed total energy is reduced to a single contour integration. The number of particles involved and their masses are arbitrary. It is shown that the contour integration may be readily approximated by the saddle-point technique and yields a result which is easily handled by a computer. In the nonrelativistic and extreme relativistic limits, this method leads to expressions for the phase space which may be obtained from the exact results for these cases by replacing Γ-function factors by the Stirling approximation. (auth)

33632 ONE-DIMENSIONAL THREE-BODY PROBLEM. **Hurley, James (Univ. of California, Davis). J. Math. Phys. (N. Y.), 8: 813-15(Apr. 1967).**

The three-body problem in one dimension is examined to determine for what class of interactions the Schrödinger equation may be solved by separation of variables. (auth)

33633 REDUCTION OF REDUCIBLE REPRESENTATIONS OF THE INFINITESIMAL GENERATORS OF THE PROPER, ORTHOCHRONOUS, INHOMOGENEOUS LORENTZ GROUP. **Lomont, J. S. (Univ. of Arizona, Tucson); Moses, H. E. J. Math. Phys. (N. Y.), 8: 837-50(Apr. 1967).**

It is shown explicitly how to reduce reducible representations of the infinitesimal generators of the proper, orthochronous, inhomogeneous Lorentz group. First a basis in which all the reducible representations are expressed as integrals of representations over masses and in which the infinitesimal generators act as in the

Foldy–Shirokov realization for nonzero masses and in the Lomont–Moses realization for zero masses is constructed. However, the spin operators which appear in the Foldy–Shirokov realizations and the generators of the Euclidean group which appear in the Lomont–Moses realizations are reducible in general. Thus reducible representations are only partially reduced in this basis. On carrying out the reduction of the spin operators and the generators of the Euclidean group, a second basis is introduced such that the reducible representations are completely reduced. By changing the emphasis slightly, the methods can be used to obtain the irreducible representations of the generators. These methods were used previously to reduce the electromagnetic vector potential and will be used to show how to reduce wavefunctions in general and also to derive the Clebsch–Gordan expansion for the direct product of two massless representations of finite spin and the same sign of energy. From the work of Mautner and Mackey it is known that every reducible unitary ray representation of the proper, orthochronous, inhomogeneous Lorentz group can be reduced to a direct integral of the irreducible representations. These techniques thus enable one to carry out the reduction explicitly. (auth)

33634 EXPONENTIAL OPERATORS AND PARAMETER DIFFERENTIATION IN QUANTUM PHYSICS. Wilcox, R. M. (National Bureau of Standards, Boulder, Colo.). J. Math. Phys. (N. Y.), 8: 962-82(Apr. 1967).

Elementary parameter-differentiation techniques are developed to systematically derive a wide variety of operator identities, expansions, and solutions to differential equations of interest to quantum physics. The treatment is largely centered around a general closed formula for the derivative of an exponential operator with respect to a parameter. Derivations are given of the Baker–Campbell–Hausdorff formula and its dual, the Zassenhaus formula. The continuous analogs of these formulas which solve the differential equation $dY(t)/dt = A(t)Y(t)$, the solutions of Magnus and Fer, respectively, are similarly derived in a recursive manner which manifestly displays the general repeated-commutator nature of these expansions and which is quite suitable for computer programming. An expansion recently obtained by Kumar and another new expansion are shown to be derivable from the Fer and Magnus solutions, respectively, in the same way. Useful similarity transformations involving linear combinations of elements of a Lie algebra are obtained. Some cases where the product $e^{A}e^{B}$ can be written as a closed-form single exponential are considered which generalize results of Sack and of Weiss and Maradudin. Closed-form single-exponential solutions to the differential equation $dY(t)/dt = A(t)Y(t)$ are obtained for two cases and compared with the corresponding multiple-exponential solutions of Wei and Norman. Normal ordering of operators is also treated and derivations, corollaries, or generalization of a number of known results are efficiently obtained. Higher derivatives of exponential and general operators are discussed by means of a formula due to Poincaré which is the operator analog of the Cauchy integral formula of complex variable theory. It is shown how results obtained by Aizu for matrix elements and traces of derivatives may be readily derived from the Poincaré formula. Some applications of the results to quantum statistics and to the Weyl prescription for converting a classical function to a quantum operator are given. A corollary to a theorem of Bloch is obtained which permits one to obtain harmonic-oscillator canonical-ensemble averages of general operators defined by the Weyl prescription. Solutions of the density-matrix equation are also discussed. It is shown that an initially canonical ensemble behaves as though its temperature remains constant with a "canonical distribution" determined by a certain fictitious Hamiltonian. (auth)

33635 DYNAMICAL ALGEBRA AND POTENTIALS. Lanik, J. (SAV, Bratislava). Nucl. Phys., B2: 263-6(1967).

The class of potentials is found from the postulated noncompact dynamical algebra of the 2 + 1 Lorentz group for one-dimensional physical systems. It is shown that each of these potentials belongs to a given unitary irreducible representation of this algebra. The possibility of using this algebra and its unitary irreducible representations for a solution of the problem of the energy spectrum for systems with more general potentials is mentioned. (auth)

33636 A CUSPED VERTEX LANDAU CURVE. Cunningham, J.; Rafique, M. (Univ. Coll. of North Wales, Bangor). Nucl. Phys., B2: 237-42(1967).

The first-type leading Landau curve for the Mercedes vertex diagram possesses at least four cusps. (auth)

33637 IDENTITIES AMONG OBSERVABLES IN SCATTERING OF PARTICLES WITH SPIN. Klepikov, N. P.; Kogan, Z. Sh.; Shamanin, S. V. (Moscow State Univ.). Yadern. Fiz., 5: 1299-1302(June 1967). (In Russian).

The ways in which identities can be constructed that are satisfied by observables in the scattering of particles with spin are indicated. Identities are given for 0, ½ and identical ½, ½ particle scattering. (auth)

33638 METHOD FOR SEPARATING DIFFERENT TYPES OF INELASTIC INTERACTIONS AT HIGH ENERGIES. Dremin, I. M. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 5: 1286-9 (June 1967). (In Russian).

The momentum transfer analysis of inelastic interactions at high energies combined with the mass analysis of excited states allows one to present a method to discriminate central and peripheral interactions as well as to investigate various types of the peripheral interactions. The errors in the calculations due to the fact that neutral particles are not taken into account and to errors in measurements of momenta are discussed. An independent test of the method is proposed at those energies when resonances are produced. (auth)

33639 MASS-SPIN RELATION IN A LAGRANGIAN MODEL. Bacry, H.; Nuyts, J. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 157: 1471-2(May 25, 1967).

It is shown that in Lagrangian models based on homogeneous spaces of the Poincaré group a mass-spin relation of the form $m^2 = a + bs$ can be derived in a natural way. (auth)

Electromagnetic

33640 (JINR–E2-3364) PHOTOPRODUCTION OF MESONS AND DIVERGENCE CONDITIONS. Montvai, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 11p. Dep.

Consequences of divergence conditions on axial-vector and tensor currents for the photoproduction of mesons near threshold are investigated. The comparison with pion production data shows that a good agreement is achieved only if one uses the "measured" value ($f_\pi = 0.138\ M_N$) of the PCAC constant. In that case from the reaction $\gamma p \to \pi^+ n$ one obtains $g_A/g_V = 1.20 \pm 0.02$ for the axial-vector coupling constant renormalization. The agreement with available data is good also for other reactions, except the $\gamma p \to K^+\Lambda$ case. In the latter case the measured value differs drastically from the predicted one, conflicting with PCAC for K-mesons or with the interpretation of semileptonic weak decays in the Cabibbo-theory. (auth)

33641 ELECTROMAGNETIC INTERACTIONS. Perez y Jorba, J. (Ecole Normale Superieure, Orsay, France). J. Phys. (Paris), Colloq., 27: C4.57-72(Nov.-Dec. 1966). (In French).

In the first part, the elastic and inelastic scattering of electrons on nucleons is studied. For elastic scattering, the interpretation of the form factors is examined in particular. The phenomenological fits are considered. The possibility of the exchange of several photons in the scattering is also examined. The inelastic scattering gives complementary information to that of photoproduction, in the sense that it allows one to study the form factors of nucleon isobars. In the second part, the main high-energy experiments which attempt to show an eventual violation of quantum electrodynamics are considered. The only possible indication of such a violation, i.e., the experiment of wide-angle electron pair production, does not seem conclusive enough at the moment to prove the non-validity of quantum electrodynamics. (auth)

33642 PAIR PRODUCTION BY PHOTONS AND PHOTON EMISSION BY ELECTRONS IN THE FIELD OF AN INTENSE ELECTROMAGNETIC WAVE OR IN CONSTANT FIELD. Nikishov, A. I.; Ritus, V. I. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 52: 1707-19(June 1967). (In Russian).

Electron–positron pair production by an energetic γ quantum in the field of an intense electromagnetic wave as a result of absorption of a large number of photons from the wave is considered. It is noted that a pronounced difference exists between the differential probabilities for pair production in the linear polarized and circular polarized waves. This difference is due to a much larger angular momentum and relative momentum of the pair in the latter case. Simple expressions for the differential probabilities of pair production by photons and photon emission by electrons are derived for the extreme case of a constant crossed field. Some arguments are presented which show that the expression should also be applicable to the case of an arbitrary constant field. (auth)

33643 THE PROBLEM OF THREE BODIES INTERACTING ACCORDING TO THE COULOMB LAW. Ponomarev, L. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 52: 1549-55(June 1967). (In Russian).

Some results are presented of a calculation of matrix elements on basis of the wave functions of the two-center problem, a knowledge of which permits one to approach the solution of many quantum mechanics problems in a new way. The possibility of applying the results obtained for description of processes involving three particles interacting according to the Coulomb law are discussed. As an example the binding energy of the $e^+e^-e^+$ system is calculated. (auth)

33644 DOUBLE LOGARITHMIC ASYMPTOTICS OF THE LARGE-ANGLE COMPTON SCATTERING. Frolov, G. V.; Gorshkov, V. G.; Gribov, V. N. (Ioffe Inst. of Physics and Tech., Leningrad). Ann. Phys. (N.Y.), 43: 201-27(June 16, 1967).

The asymptotics of the large-angle Compton scattering is obtained in a double logarithmic approximation. The asymptotics were calculated by summing up the asymptotic contributions of the Feynman diagrams. It is shown that diagrams both containing and having no infrared divergences are significant. The asymptotics of the amplitude is of the form $f_0 \exp[-(\alpha/4\pi) \ln^2 s]$. The asymptotic behavior of the cross section was found for different ways of measuring the accompanying bremsstrahlung radiation. The total cross section of elastic scattering and bremsstrahlung radiation with no limitations imposed on the energy of bremsstrahlung quanta does not contain double logarithmic terms and is equal to the asymptotics of the Klein–Nishina–Tamm cross section. (auth)

33645 FEYNMAN RULES IN STATISTICAL MECHANICS. Grisaru, M. T.; Zaidi, M. H. (Brandeis Univ., Waltham, Mass.). Contract AF 19(628)-4019. Nuovo Cim. (10), 50B: 17-26(July 11, 1967).

A definition of normal product of Bose fields is given and it is shown that the average value of such a product over the grand canonical ensemble vanishes. The definition is useful when considering a relativistic electron gas in interaction with radiation since it very naturally leads to rules of calculation similar to the ordinary Feynman rules. (auth)

33646 SUPERCONVERGENT AMPLITUDES IN NUCLEON COMPTON SCATTERING. Choudhury, S. Rai (Princeton Univ., N. J.). Phys. Rev. Lett., 19: 96-8(July 10, 1967).

A superconvergent sum rule is derived for nucleon Compton scattering. The sum rule is a relation between the nucleon magnetic moment and an integral over the imaginary part of the superconvergent amplitude; the latter is evaluated by retaining the π-N intermediate state, the imaginary part then is expressible as bilinear combinations of photomeson production amplitudes. The good agreement found with experiment is regarded as indicating the usefulness of simple superconvergence relations in correlating experimental results. (L.B.S.)

33647 PROTON-RECOIL CORRECTIONS TO THE HYPERFINE SPLITTING OF THE HYDROGEN ATOM. Guerin, F. (Faculte des Sciences, Orsay, France). Nuovo Cim. (10), 50A: 1-36(July 1, 1967).

A very simple method is presented for the calculation of the corrections that depend on the proton mass in the hyperfine splitting of the hydrogen atom, for the case of a point proton. The calculation is straightforward, but the proof is rather long and involves the use of the Bethe–Salpeter equation. The low-energy theorem for Compton scattering is generalized to the case of virtual photons, in order to prove rigorously that the corrections arising from the structure of the proton will not involve the electron mass, and will depend only on the spin-dependent part of the forward photon-proton scattering amplitude. A breakdown of quantum electrodynamics which assumes a modified photon propagator or a modified photon-electron vertex cannot remove the discrepancy between theory and experiment. (auth)

33648 THEORY OF RENORMALIZATION AND COMPTON SCATTERING IN QUANTUM ELECTRODYNAMICS OF COHERENT LIGHT OF HIGH INTENSITY. Ehlotzky, F. (Univ. of Innsbruck). Z. Phys., 203: 119-40(1967).

The Feynman propagator of an electron interacting with an intense beam of monochromatic and linearly polarized light of low frequency is evaluated. The technique of Feynman-graph summation developed previously is employed and Volkov boundary conditions are adopted. The mass- and momentum-shifts found previously are re-examined and the influence of spin, polarization and boundary conditions is discussed. The renormalization procedure is generalized such as to include also the modification of a true scattering vertex, and as a specific application the intensity dependent amplitude of the Compton effect is calculated. (auth)

33649 ELECTROMAGNETIC PROPERTIES OF MESONS IN THE QUARK MODEL. Ishida, Shin (Boston Univ.); Konno, Kimiaki; Roman, P.; Shimodaira, Hajime. Nucl. Phys., B2: 307-15(1967).

It is assumed that the electromagnetic (e.m.) interactions occur via the individual, nonrelativistic quark and antiquark constituents of the meson, neglecting exchange currents and annihilation currents, but allowing for a vector meson cloud structure of the quarks. A simple expression is obtained for the e.m. form factors of all PS and V mesons, from which interesting relations follow. Assuming that the e.m. mass differences between mesons are due to both the e.m. mass splitting of quarks and the e.m. interactions between constituent quarks, mass formulas are derived which, in the case of broken symmetry, result in four inequalities. For the sake of illustration, two specific models are also considered and individual numerical values are calculated. All results appear to be consistent with the presently available experimental data. (auth)

33650 THE CLASSICAL DESCRIPTION OF A NEUTRON SCATTERED BY A COULOMB POTENTIAL. Lu, P. (Arizona State Univ., Tempe). Nuovo Cim. (10), 50A: 237-43(July 21, 1967).

Good's equations are solved for a neutron moving in a Coulomb potential. It is found that the cross section of scattering is more singular than Schwinger's Born approximation calculations; the validity of the classical approximation is discussed and it can only be applied to small forward angles. (auth)

33651 DOUBLE PROTON EMISSION IN e^+e^- COLLISIONS. Di Vecchia, P.; Greco, M. (CNEN, Frascati, Italy). Nuovo Cim. (10), 50A: 319-32(July 21, 1967). (LNF-67/12).

For the process $e^+ + e^- \rightarrow e^+ + e^- + 2\gamma$, the angular distribution of the two photons, their energy spectrum, and the total cross section for emitted photons of energy $\geq\epsilon$ are evaluated in the extreme relativistic limit. (auth)

33652 ANALYSIS OF γ-p ELASTIC SCATTERING IN THE ENERGY REGION 120 TO 280 MeV. Baranov, P. S.; Kuznetsova, V. A.; Slovokhotov, L. I.; Sokol, G. A.; Fil'kov, L. V.; Shtarkov, L. N. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 5: 1221-31(June 1967). (In Russian).

For γ–p elastic scattering in the energy region 120 to 280 MeV the experimental data are compared with the theoretical calculations based on dispersion relations with subtraction at fixed momentum transfer. In the energy range E_γ from 180 to 220 MeV the theoretical calculations are in strong disagreement with the experimental data. In the energy range E_γ from 240 to 280 MeV the experiments agree with the calculation which include the effect of the annihilation channel and assume the positive relative sign for the contribution of the π^0-meson pole. (auth)

33653 ON THE MULTIPOLE ANALYSIS OF CHARGED-PION PHOTOPRODUCTION BY POLARIZED γ RAYS. Nigro, M.; Schiavuta, E. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim. (10), 50A: 358-63(July 21, 1967).

It is shown how measurements of the cross section for charged-pion production by linearly polarized gamma rays allow a significant improvement in the experimental determination of the multipoles. In particular, the difference between "ordinary" and "polarized" cross sections in the region of 200 to 400 MeV is discussed. (L.B.S.)

33654 IS THE EQUALITY OF THE ELECTRIC AND MAGNETIC PROTON FORM FACTORS EXACT? Anisovich, V. V.; Gershtein, S. S.; Folomeshkin, V. N. JETP Lett. (USSR) Engl. Transl.), 5: 277-9(May 1, 1967).

Since the good agreement obtained between the electric and magnetic proton form factors satisfying the rule $G_E^p(q^2) = G_M^p(q^2)\,\mu_p$ is surprising, it is of interest to assume that for some unknown reason this relation is exact for arbitrary q^2, and consider the experimental consequences that ensue from this assumption. It is shown that the experimental data on $p\bar{p}$ annihilation at rest agree with this assumption. (J.F.P.)

33655 DISPERSION SUM RULES AND MAGNETIC MOMENTS OF HYPERONS. Pisarenko, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 1278-82(June 1967). (In Russian).

The values for the magnetic moments of hyperons are obtained on the basis of dispersion sum rules for π- and K-meson photoproduction on baryons without algebra of currents. The results agree with the SU(3)-symmetry predictions and available experimental data. (auth)

33656 PROPERTIES OF CROSS SECTIONS FOR ANNIHILATION OF THE POLARIZED ELECTRON–POSITRON PAIR. Baier, V. N.; Khoze, V. A. (Novosibirsk State Univ., USSR). Yadern. Fiz., 5: 1257-62(June 1967). (In Russian).

Some properties of cross sections are considered for the annihilation of the polarized electron-positron pair. The general form of the annihilation cross section is found for the arbitrarily polarized pair in the ultrarelativistic limit. Creations of pseudoscalar mesons and of plane-polarized photons at the annihilation

of the pair with transverse polarization are investigated. The explicit cross sections for the processes $e^+ + e^- \rightarrow \mu^+ + \mu^- + \gamma$, $e^+ + e^- \rightarrow s^+ + s^- + \gamma$ (s is a scalar, or pseudoscalar particle) are obtained for the incident pair with transverse polarization. (auth)

33657 DISPERSION SUM RULE FOR MAGNETIC MOMENTS AND SPIN DEPENDENCE OF PHOTOABSORPTION CROSS SECTION. Gerasimov, S. B. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 1263-9(June 1967). (In Russian).

The spin dependence of the absorption of photons by nucleons and nuclei is discussed on the basis of dispersion sum rule. The obtained estimations show the importance of spin effects on the interaction of nucleons and photons with an energy $\omega > 1$ GeV. The sum rule is used to show that in the framework of Fermi-gas model for a nucleus the Pauli principle increases an anomalous magnetic moment of a bound nucleon by 4–6% compared to a free nucleon. (auth)

33658 DISPERSION SUM RULES AND THE CABIBBO–RADICATI RELATION. Kallosh, R. E.; Pisarenko, V. G.; Faustov, R. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 1270-3(June 1967). (In Russian).

Sum rules for electroproduction and the Cabbibo–Radicati relation are shown to result possibly from a certain assumption about the high-energy behavior of the virtual isovector amplitude of the proton Compton scattering without any use of the current algebra. (auth)

33659 BACK ELECTROMAGNETIC SCATTERING OF LEPTONS FROM NUCLEONS. Takwale, R. G. (Univ. of Poona). Phys. Rev., 157: 1326-7(May 25, 1967).

The expression for the cross section for the back electromagnetic scattering of leptons and antileptons from nucleons in the laboratory system is given in the first-order Born approximation. The expression includes the dependence on spin states of both particles, which are described by the corresponding electromagnetic form factors. It is shown that the spin flip of leptons is a result of their electromagnetic structure. (auth)

33660 NEUTRAL VECTOR MESONS AND THE HADRONIC ELECTROMAGNETIC CURRENT. Kroll, Norman M. (Univ. of California, San Diego, La Jolla); Lee, T. D.; Zumino, Bruno. Phys. Rev., 157: 1376-99(May 25, 1967).

The question of whether the entire hadronic electromagnetic current operator can be identical with a linear combination of the renormalized field operators for the known neutral vector mesons ρ^0, ϕ^0, and ω^0 is investigated in the context of a Lagrangian field theory. It is found that such an identity is completely consistent with gauge invariance, provided that these mesons are coupled only to conserved currents. The general renormalization problem of the strong interactions of these vector mesons is discussed. It is shown that the proposed identity between the hadronic electromagnetic current and the renormalized meson fields can be related to the possible identity between the unrenormalized currents generating the neutral vector mesons and those generating the photon; furthermore, this proposed identity leads to an exact relation between the entire $O(e^2)$ hadronic contribution to the photon propagator and the renormalized propagators of the neutral vector mesons, and such a relation implies, among other consequences, that to $O(e^2)$ and neglecting leptonic contributions, the ratio of the unrenormalized charge e_0 and the renormalized charge e is finite. Various experimental applications are given. In particular, the analysis of ϕ-ω mixing and their leptonic decay rates is made independently of the approximate validity of the SU_3 symmetry. (auth)

33661 ELECTROMAGNETIC FORM FACTORS FOR COMPOSITE PARTICLES AT LARGE MOMENTUM TRANSFER. Drell, S. D.; Finn, A. C.; Goldhaber, Michael H. (Stanford Linear Accelerator Center, Calif.). Contract AT(94-3)-400. Phys. Rev., 157: 1402-11(May 25, 1967). (SLAC-PUB-237).

Experimental information now exists on the behavior of electromagnetic form factors F(q) at very high momentum transfer q. This has led to speculations on the asymptotic behavior of the form factors as $q \rightarrow \infty$. Nonrelativistic Schrödinger models of composite systems are considered and the asymptotic behavior of F(q) is correlated with the nature of the forces in the limit of zero interparticle separation. Conditions for falloff more rapid than powers of 1/q are analyzed, and comparisons with proton and deuteron data are presented. (auth)

33662 ELECTROMAGNETIC MASS SPLITTINGS OF THE BARYON OCTET. Cohen, S. L.; Hagen, C. R. (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Phys. Rev., 157: 1344-51(May 25, 1967). (UR-875-175).

It is assumed that the electromagnetic mass splittings within the baryon octet can be self-consistently calculated from the one-photon elastic form-factor contribution and the electromagnetic mass differences within the pseudoscalar-meson octet. The baryon mass differences are shown to be expressible as functions of three parameters: a cutoff Λ, the f/d ratio, and the pion-nucleon coupling constant. A unique set of real values for these parameters is found which correctly predicts both the sign and magnitude of all the electromagnetic baryon mass splittings. The pion-nucleon coupling constant is found to be equal to 16.7, in good agreement with experiment. (auth)

Weak

33663 (NYO-2262TA-143) DECAY RATE OF $K_2^0 \rightarrow 2\pi^0$ AND CHARGE ASYMMETRY IN $K_2^0 \rightarrow \pi^{\pm} l^{\mp} \nu$ DECAYS. Truong, Tran N. (Brown Univ., Providence, R. I. Dept. of Physics). Jan. 1967. Contract AT(30-1)-2262. 15p. (CONF-670211-1). Dep. CFSTI.

From Symposium on CP Noninvariance, Argonne, Ill.

Under the assumptions $0 \leq \arg \eta_+ \leq 90°$ and $1.6 \leq \eta_{00}/\eta_+ \leq 3.0$ as indicated by recent experiments, the measurement of the charge asymmetry in $K_2^0 \rightarrow \pi^{\pm} l^{\mp} \nu$ can be used to distinguish the large solution of ϵ from the smaller one. This result is independent of any assumption on the S-wave pion pion phase shifts and is insensitive to the value assumed for $\arg \eta_+$. If the small solution is verified experimentally, the source of CP violation is very likely in $\Delta I \geq 3/2$ interaction. (auth)

33664 EXPERIMENTAL RESULTS ON SELECTION RULES AND PC CONSERVATION IN K-MESON DECAYS. Behr, L. (Ecole Polytechnique, Paris). J. Phys. (Paris), Colloq., 27: C4.40-8(Nov.-Dec. 1966). (In French).

The validity of the phenomenological selection rules in K-meson decays is investigated, on the basis of the available experimental results. The conclusion is that the situation is still far from being clarified: the upper limits for violation of the $\Delta S = \Delta Q$ and leptonic or hadronic $\Delta I = 1/2$ selection rules, are not always negligible. As to PC violation, which has been observed only in $K_L^0 \rightarrow \pi^+ \pi^-$ decays so far, the available results do not allow one to choose among the different theoretical models. (auth)

33665 ALGEBRA OF CURRENTS. Bouchiat, C.; Meyer, Ph. (Faculte des Sciences, Orsay, France). J. Phys. (Paris), Colloq., 27: C4.73-9(Nov.-Dec. 1966). (In French).

After an elementary introduction to the algebra of currents, a number of applications are considered among which are the evaluation of G_A, the renormalized axial coupling constant of β decay, as well as different sum rules involving electromagnetic processes. Furthermore the algebra of currents combined with the partially conserved axial-current hypothesis is used to derive some low-energy theorems concerning nonleptonic decays of hadrons involving one or more soft pions. (auth)

33666 NONLEPTONIC DECAYS OF HYPERONS. Murtaza, G.; O'Donnell, P. J. (Univ. of Toronto). Can. J. Phys., 45: 2375-82(July 1967).

The s- and p-wave mesonic decays of hyperons are studied in the context of a general Hamiltonian of a current × current type. The form of the Hamiltonian chosen allows a distinction to be made between the $\Delta I = 1/2$ and $\Delta I = 3/2$ contributions and thus clarifies the role of octet enhancement vis à vis that of the $\Delta I = 1/2$ rule. A simple assumption, less restrictive than octet dominance, about the Hamiltonian yields all the $\Delta I = 1/2$ rules for both s- and p-wave decays and the result that $\Sigma^+ \rightarrow n\pi^+$ decay is purely p wave. A new sum rule is obtained which determines, fairly accurately, the ratio F/(D + F) for Yukawa-type coupling, giving the result 0.356 ± 0.068. (auth)

33667 CONVERGENT CALCULATION OF NONLEPTONIC K DECAY IN THE INTERMEDIATE-BOSON MODEL. Glashow, S. L. (Harvard Univ., Cambridge, Mass.); Schnitzer, Howard J.; Weinberg, Steven. Phys. Rev. Lett., 19: 205-8(July 24, 1967).

The nonleptonic decay amplitudes of the K mesons are calculated using current algebra and the spectral-function sum rules. The result is convergent in the intermediate-boson model, but not for a direct current-current interaction. Comparison with the observed rate for K_1^0 decay shows that the intermediate-boson mass is about 8 BeV. (auth)

33668 SUPERFLUIDITY OF THE COSMOLOGICAL NEUTRINO "SEA". Ginzburg, V. L.; Zharkov, G. F. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 5: 223-5 (Apr. 15, 1967).

Translated from Zh. Eksp. Theort. Fiz., Pis'ma Rekdat., 5: 275-7(Apr. 15, 1967).

Although it is usually assumed in cosmological models that the neutrinos form an ideal gas, yet they interact with one another, which under the conditions of a degenerate Fermi gas can lead to a superfluidity phenomenon, similar to superconductivity of electrons in a metal. In this connection the question of the possible

superfluidity of the neutrino sea is formulated using the ordinary superconductivity theory of Bardeen, Cooper, and Schrieffer in a previous formulation where the interaction is described by the Hamiltonian $\lambda/2 \int (\psi^*(\psi^*\psi)\psi)dz$. The appearance of Dirac matrices in this expression for neutrinos is disregarded, and it is assumed only that the energy of the elementary excitations (neutrinos) is of the form $\zeta = c(p - p_F)$, where p_F is the momentum at the Fermi boundary and c is the velocity of light. In addition it is easy to ascertain that, for a given momentum, the neutrino spin can have only one direction. (J.F.P.)

33669 STRANGE PARTICLE PRODUCTION BY NEUTRINO BEAM AND THE $\tilde{U}(12)$ SYMMETRY. Laperashvili, L. V. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 46: 327-32(May 1967). (In Russian).

Total cross sections of $\bar{\nu} + p \rightarrow \Lambda^0 + \mu^+$ and $\bar{\nu} + n \rightarrow \Sigma^- + \mu^+$ processes were calculated in two theoretical variations. In the first variation it was assumed that the Pauli $F_1(q^2)$ and Dirac $F_2(q^2)$ electromagnetic form factors of a nucleon are generally completely determined by the electromagnetic vertex with vector meson exchange which belongs to the concept of the $\tilde{U}(12)$ 143 group with the central mass m. The second variations examined a polar approximation of R. G. Sachs (Phys. Rev., 126: 2256, (1962)) form factors in the kineto-theory of U(12) symmetry scheme. (R.V.J.)

33670 FINAL-STATE INTERACTION EFFECTS ON β FOR THE NONLEPTONIC HYPERON DECAYS. Hussain, F.; Rotelli, P. (Univ. of Chicago). Nuovo Cim. (10), 50A: 152-5(July 1, 1967). (COO-264-354).

The $|\Delta I| = 1/2$ rule, final-state interactions and CP invariance are used to evaluate the β asymmetry parameters for the nonleptonic hyperon decays. It is concluded that present experimental data do not rule out CP violation in these decays. (auth)

33671 QUARK APPROACH TO PARITY-VIOLATING NONLEPTONIC DECAYS. Copley, L. A. (Univ. of Toronto, Ont.). Nuovo Cim. (10), 50A: 185-90(July 1, 1967).

A quark model approach to the S-wave decays $B' \rightarrow B + \pi$ and $K \rightarrow 2\pi$ is described and used to obtain a connection between them. The method differs from previous quark model applications to semileptonic decays and baryon-meson coupling in that the quark model is combined with current algebra. In particular, the conventional Suzaki-Sugawara technique of contracting out a final-state pion is used, applying PCAC and then using the commutation relations of the axial-vector charge with the current-current Hamiltonian before introducing quarks into the problem. (L.B.S.)

33672 K_{2S}-K_{1S} MASS DIFFERENCE IN THE POLE DOMINANCE MODEL. Zimerman, A. H. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Nucl. Phys., B2: 234-6(1967).

The K_{2S}-K_{1S} mass difference is discussed by means of a single dynamical model proposed by Sakurai. (auth)

33673 THE $\Delta I = 1/2$ RULE WITHOUT NEUTRAL CURRENTS. Feldman, G. (Johns Hopkins Univ., Baltimore); Fulton, T.; Matthews, P. T. Nuovo Cim. (10), 50A: 349-54(July 21, 1967).

Charged scalar and vector hadron currents are defined. Using the properties of the Fierz transformation on γ-matrices, it is shown that a suitable combination of such charged currents can lead to an effective $\Delta I = 1/2$ rule for the nonleptonic decays. The leptonic decays of nonstrange particles are still mediated by the usual (V-A) interaction. However, the form of the unrenormalized strangeness-changing semileptonic interaction is V + A. (auth)

33674 POSSIBILITY TO TEST THE CP-INVARIANCE IN $K_2^0 \rightarrow 3\pi$ DECAYS IN CORRELATION EXPERIMENTS WITH $K^0\bar{K}^0$ PAIRS. Lukstyn'sh, Yu.; Okonov, E. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 1246-8(June 1967). (In Russian).

The correlation experiments with $K^0\bar{K}^0$ pairs are considered which make it possible to observe and study the CP-forbidden $K_2^0 \rightarrow 3\pi$ decays in pure condition. The experimental procedure may be adjusted so as to provide a pronounced interference in the $K_2^0 \rightarrow 3\pi$ and $K_L^0 \rightarrow 3\pi$ decays. The possibility to study the $K_2^0 \rightarrow K_L^0$ regeneration experimentally is noted. (auth)

33675 ON THE $\Omega^- \rightarrow \Xi + \iota^- + \bar{\nu}$ DECAY. Lyul'ka, V. A. Yadern. Fiz., 5: 1249-52(June 1967). (In Russian).

Leptonic decays of the Ω^--hyperon are considered. Expressions are obtained for the decay probability with the Ξ-hyperon and the muon in a given polarization state. The energy spectra and the polarizations of the Ξ-hyperons and the leptons are calculated neglecting induced form factors. Some estimates are given also of the possible effect of the induced form factors on the polarizations of the particles in the decay. (auth)

33676 INTERACTIONS OF NEUTRINO WITH RELATIVISTIC ELECTRONS AND COSMIC NEUTRINO. Vanzha, A.; Lapidus, L. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 1253-6(June 1967). (In Russian).

Phenomenon is considered of neutrino "hardening" at collisions of low-energy neutrinos with relativistic electrons resulting in the elastic scattering and in the conversion into the pair muon-muonic neutrino. From the V-A theory it follows that the energy spectrum in the final state is uniform for the processes of leptonic neutrino interaction with electrons. As for the neutrino-positron interaction the neutrino energy spectrum drops to zero at the maximal energy but the mean neutrino energy is about 1/4 of the initial electron energy. The phenomenon in view can play a role in the interactions of the leptonic neutrinos from stars with the relativistic electrons in the universe. (auth)

33677 WEAK RADIATIVE HYPERON DECAYS, AND THE QUARK MODEL OF ELEMENTARY PARTICLES. Rekalo, M. P. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 12: 489-90 (Mar. 1967). (In Russian).

Each of the possible reactions $\Lambda \rightarrow n + \gamma$, $\Sigma^+ \rightarrow p + \gamma$, $\Sigma^0 \rightarrow n + \gamma$, $\Xi^0 \rightarrow \Sigma^0 + \gamma$, $\Xi^0 \rightarrow \Lambda + \gamma$, $\Xi^- \rightarrow \Sigma^- + \gamma$ can be described in the form: $K^0_{(s)} + Y \rightarrow Y' + \gamma$. Here $K^0_{(s)}$ is a weak spurion possessing positive strangeness and an isotopic spin of 1/2, and is converted analogously to a K^0-meson according to an octet representation of a SU(3) group. It can be understood that $K^0_{(s)}$ consists of a quark and an antiquark ($K^0_{(s)} = \bar{\lambda}'n'$). The quark content of the hyperons is known. Relations between the amplitudes of weak radiative hyperon decays are derived by additively obtaining the scattering amplitudes of the individual quarks. Two types of gamma quanta are formed in the $Y \rightarrow Y' + \gamma$ decays: magnetic dipole gamma quanta (without violating parity conservation) and electric dipole gamma quanta (with violation of parity conservation). It is assumed that this model is applicable to decays violating parity conservation. (TTT)

33678 NEUTRAL SEMILEPTONIC DECAYS OF K MESONS. de Rafael, Eduardo (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 157: 1486-9(May 25, 1967).

The question of the existence of neutral leptonic currents coupled to the neutral strangeness-changing current is discussed in the light of recent experimental limits on $K_2^0 \rightarrow \mu^+\mu^-$ and $K_2^0 \rightarrow e^+e^-$ decay rates. (auth)

33679 UNSUBTRACTED DISPERSION RELATIONS IN WEAK INTERACTIONS AND UNITARY SYMMETRY. II. Nishijima, K. (Tokyo Univ.). Phys. Rev., 157: 1459-70(May 25, 1967).

In a previous paper a dynamical approach to weak interactions was proposed based on unsubtracted dispersion relations, and in the present paper this approach is further developed. It is first shown that this theory reproduces the experimental data of the nonleptonic decays of hyperons fairly well. Then, the consistency conditions imposed on the second-order matrix elements in weak interactions are examined. It is shown that the current commutation relations as well as CP violation in the $K_2 \rightarrow 2\pi$ decay are inevitable consequences of the consistency conditions. (auth)

33680 THEORY OF NONLEPTONIC DECAYS. II. $K \rightarrow 2\pi$. Chiu, Y. T. (Univ. of Chicago); Schechter, J.; Ueda, Y. Contract AT(11-1)-264. Phys. Rev., 157: 1317-22(May 25, 1967). (COO-264-336; EFINS-66-74).

An attempt is made to calculate all three CP-conserving $K \rightarrow 2\pi$ decay amplitudes from the universal current-current picture of weak interactions. In this model the suppression of the $K^+ \rightarrow \pi^+\pi^0$ mode seems to come about as a result of a cancellation between the pseudoscalar-meson octet and effective scalar-meson singlet intermediate-state contributions to the current-current "spurion." (auth)

33681 CURRENT ALGEBRA AND NON-REGGE BEHAVIOR OF WEAK AMPLITUDES. II. Bronzan, J. B. (Massachusetts Inst. of Tech., Cambridge); Gerstein, I. S.; Lee, B. W.; Low, F. E. Contract AT(30-1)-2098. Phys. Rev., 157: 1448-57(May 25, 1967). (MIT-2098-313).

Certain weak amplitudes exhibit non-Reggeistic behavior. These amplitudes have fixed poles in the complex angular-momentum plane which have the dual property of allowing a sum rule of the Dashen-Gell-Mann-Fubini type to hold, although one might naively expect a superconvergence relation for this amplitude, and insuring that spin-one particle poles are reproduced correctly in the left-hand side of the sum rule. The existence of the fixed pole is demonstrated directly by comparing the sum rule with the Froissart-Grivov continuation to the complex J plane. Some models which exhibit this behavior are also studied. (auth)

Strong (General)

33682 INTERACTION MECHANISMS OF TWO BODIES AT HIGH ENERGY. Sonderegger, P. (CEN, Saclay, France). J. Phys. (Paris), Colloq., 27: C4.11-22(Nov.-Dec. 1966). (In French).

The distinction is made between diffraction scattering, which

includes a class of inelastic reactions, and exchange scattering. The exchange processes are in good agreement with the Regge-pole model, while the connection between this model and the diffraction mechanism is still obscure. The quark model is quoted as a promising outlook. (auth)

33683 RESONANCES. Montanet, L. (CERN, Geneva). J. Phys. (Paris), Colloq., 27: C4,80-97(Nov.-Dec. 1966). (In French).

The experimental situation for mesons is presented. In particular, the η'-δ^* (962 MeV) difficulty and the $(K\bar{K})$ threshold effects are studied, and different results obtained for $(K\bar{K})$, $(K\bar{K}\pi)$, and $(\rho\pi)$ systems near 1,300 MeV are compared. The possible quantum numbers for the E-meson are analyzed. The experimental situation of the S = ±1 mesons is also briefly reviewed. (auth)

33684 NONINVARIANCE GROUP BY BOOTSTRAP AND REGGE BEHAVIOR. Gleeson, Austin M.; Musto, Renato (Syracuse Univ., New York). Phys. Rev. Lett., 19: 175-7(July 24, 1967). (NYO-3399-97; SU-1206-97).

By means of Regge theory and bootstraps, a chiral SU(2) ⊗ SU(2) noninvariance algebra of the meson isobar coupling strengths is motivated. The equivalence of these approaches is discussed and the algebra is compared with the previously postulated algebras of the meson isobar system. (auth)

33685 SPIN AND ISOSPIN. Hestenes, David (Princeton Univ., N. J.). J. Math. Phys. (N. Y.), 8: 809-12(Apr. 1967).

Spinor fields can be classified according to the invariants of their derivatives. It is suggested that different invariants describe different interactions of elementary particles. Then the classification of spinor fields becomes a classification of elementary particles and their interactions. A geometric interpretation of isospin is suggested and is used in a model of nucleon interactions. This theory entails an intimate connection between spin and isospin which appears to have some experimental support. Among other things, it connects the pseudoscalar and isospin properties of the pion and accounts for the polarization of the third axis in isospace by the electromagnetic interactions. (auth)

33686 A DERIVATION OF VELTMAN'S EQUATIONS IN CLASSICAL FIELD THEORY. Bouchiat, C.; Flamand, G.; Kaplan, J. M. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim. (10), 50A: 265-71(July 21, 1967).

Veltman's equations are derived from a generalized principle of minimality and a further condition on the strong interactions, within the framework of classical Lagrangian field theory. The Poisson bracket algebra of the charge densities holds without the latter supplementary condition but "Schwinger terms" may appear in the brackets involving space components. (auth)

33687 HIGH-ENERGY MULTIPARTICLE PRODUCTION AND ELASTIC-SCATTERING PROCESSES. Satz, H.; van Keuk, G. (DESY, Hamburg). Nuovo Cim. (10), 50A: 272-86(July 21, 1967).

For many-particle production a model which assumes at fixed impact parameter a statistical picture of fireball formation and decay is studied. In this way on the one hand for the usual statistical model an extension is obtained which includes angular-momentum conservation and allows predictions for all inelastic and corresponding absorptive elastic cross sections, on the other a "central collision" counterpart of the peripheral model. The asymptotic predictions for production processes are discussed and compared to those of the usual statistical model and of the multiperipheral model. The resulting form of elastic and total cross-sections, obtained by unitarity, agrees with that given by Van Hove's uncorrelated particle model. (auth)

33688 BOUND-STATE EQUATION FOR QUARK–ANTIQUARK SYSTEMS. Delbourgo, R.; Salam, A.; Strathdee, J. (IAEA, Trieste, Italy. Imperial Coll. of Science and Technology, London). Nuovo Cim. (10), 50A: 193-210(July 21, 1967).

The Bethe-Salpeter equation for spinor quark-antiquark binding in the ladder approximation is studied in terms of projective variables. These variables exhibit the maximal symmetry of the problem as an O_5 symmetry for special values of masses involved. The realistic Bethe-Salpeter equation is treated as corresponding to a broken O_5 symmetry situation. Among other advantages of this approach is that the continuum eigenvalue difficulties for the bound states encountered in other treatments seem obviated. (auth)

33689 CHARGE- AND STRANGENESS-EXCHANGE REACTIONS IN THE QUARK MODEL. Kajantie, K.; Trefil, J. S. (CERN, Geneva). Nucl. Phys., B2: 243-8(1967).

Relations for cross sections and density matrix elements for charge and strangeness exchange reactions are derived, using the quark model. The density-matrix relations are shown to be more meaningful tests of the model than those for cross sections. The effects of annihilation channels, not described by the quark model, are discussed. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 33687.

33690 (JINR-P2-3353) K VOPROSU O SPEKTRE MASS MEZONOV V MODELI KVARKOV. (On the Problem of the Meson Mass Spectrum in Quark Model). Kuleshov, S. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 7p. (In Russian). Dep.

The problem for eigenvalues and eigenfunctions for the relativistic quark equation, drawn by P. N. Bogolubov, is solved. The relation, determining the meson mass spectrum in the quark model, is obtained. (auth)

33691 ON THE ISLAM–KANG MODEL FOR DYNAMIC CALCULATION OF INELASTICITY. Chermalykh, G. N. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 723-5(May 1967). (In Russian).

The model approach proposed by Islam and Kang for the calculation of the inelasticity coefficient $\eta_1 = e^{-2\delta_1^1}$ from jointly given partial-wave amplitude discontinuities on the left and inelastic cuts is applied to a p-wave pion-pion system. The phase of the Froissart auxiliary amplitude is taken from the Balazs strip N/D model. The approximate solution of the equation for δ_1^1 gives the ρ-resonance width somewhat larger than in the purely elastic case. The asymptotic properties of the exact solution of the equation for $\delta_1^1(\nu)$ with $\nu \to \infty$ are also considered. (auth)

33692 SOME REMARKS ON HIGHER MESONS. Sutherland, D. G. (CERN, Geneva). Nucl. Phys., B2: 157-63(1967).

A model based on exchange degeneracy and linear trajectories is given to correlate presently known meson resonances with I = 1. A critical discussion is given of some features of this model. Some remarks are made on the problem of the widths of the higher mesons in this scheme and on some related problems in higher meson spectroscopy. (auth)

33693 BARYON–ANTIBARYON PAIR PRODUCTION IN A QUARK MODEL. Badier, S. (Univ., Paris, Orsay, France). Nuovo Cim. (10), 50A: 313-18(July 21, 1967).

The production of baryon–antibaryon pairs in antiproton–proton collisions are studied in the framework of the quark model. A conservation law approximated for the spin of the interacting particles in particular permits calculation of the cross sections for the pairs in the octet and the decuplet of SU(3). The comparison with experimental values, in spite of large uncertainties in the measurements, seems to give satisfactory results considering the approximations of the proposed model. (tr-auth)

33694 COALESCENCE OF BOSON REGGE TRAJECTORIES AT t ≤ 0. Volkov, D. V. (Physical-Technical Inst., Kiev). JETP Lett (USSR) (Engl. Transl.), 5: 281-3(May 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 341-4(May 1, 1967).

Arguments indicating that the coalescence of the Regge trajectories and their emergence to the complex plane, observed previously for the case of fermion trajectories, are possible also for boson trajectories. A model is used based on the summation of the asymptotic contribution of the scattering amplitude diagrams of particles with half-integer spin under the additional assumption that the integrals over the closed loops, which arise upon contraction of the meson lines and converge for the case of particles with zero spin, are convergent also for particles with spin. (J.F.P.)

33695 DISPERSION SUM RULES FOR ANNIHILATION $b + \bar{b} \to P_1 + P_2$. Matveev, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 1274-7(June 1967). (In Russian).

The dispersion sum rules for the annihilation $b + \bar{b} \to P_1 + P_2$ of the baryon and antibaryon octets into two meson octets is considered in the framework of the SU(3) symmetry under the assumption of dispersion relations without subtraction for the some amplitudes. The sum rule for the processes involving nonstrange particles are in good agreement with the experimental data. (auth)

33696 PRODUCTION OF N*(1236) AND Y_1*(1382) IN NUCLEON–ANTINUCLEON COLLISIONS. Sweig, Mitchel J. (Univ. of Chicago). Phys. Rev., 157: 1420-31(May 25, 1967). (COO-264-348; EFINS-66-89).

The absorption model was applied to the production of N*(1238) and Y_1^*(1382), both singly and in pairs, in $\bar{p}N$ collisions. The shapes of the differential cross sections and the decay distributions are in agreement with exchange of a pseudoscalar meson, but the predicted magnitudes of the differential cross sections are generally

too large. This discrepancy decreases with increasing energy. A combination of vector and pseudoscalar exchange improves the prediction for the magnitude of $d\sigma/dt$ (over a restricted range in momentum transfer) but is unable to fit the observed decay distributions, and therefore seems to be excluded. Analysis of the reactions involving strange particles is hampered by insufficient data, but a comparison of the predicted and observed $\Sigma Y_1^*/\Lambda Y_1^*$ ratio again indicates pseudoscalar exchange with $D + \frac{2}{3}F$ coupling. Some suggestions are made to explain the improved agreement between theory and experiment at the higher energies. (auth)

33697 STRIP APPROXIMATION AND THE SHAPE OF THE DIFFRACTION PEAK. Collins, P. D. B. (Univ. of Durham, Eng.). Phys. Rev., 157: 1432-40(May 25, 1967).

It is pointed out that the sharpness of the diffraction peak is incompatible with the usual justification of the strip approximation to the Mandelstam representation. Discrepancies between the Regge residue functions needed to fit experiment and those obtained from dynamical calculations using the new form of the strip approximation are discussed. It is shown that if the correct shape of the diffraction peak is to be reproduced there are special requirements as to the form of the force—that it oscillate in sign within the strip—which are not satisfied by the Born approximation to that force. It is indicated how the correct expression for the force may rectify this, and an attempt is made to discover what difference having the right sort of residues would make in the slope of the trajectories in π-π scattering, by imposing the experimental shape on the residues artificially. The trajectory slopes are found to be improved, but the drastic nature of the change produced by imposing the experimental form on the output residues makes a bootstrap impossible if only the Born approximation to the force is used. (auth)

33698 DISPERSION SUM RULES FOR NUCLEON–ANTINUCLEON SCATTERING. Bose, Subir; Bose, Shubha; Bondyopadhyay, D. (Univ. of Delhi). Phys. Rev., 157: 1441-4(May 25, 1967).

Nucleon-antinucleon scattering is considered in order to derive two sum rules, which follow from the one-dimensional dispersion relations for a fixed momentum transfer, under some assumptions about the high-energy behavior of the invariant amplitudes. The sum rules give simple relations between the various meson-baryon coupling constants and the parameters required to characterize the deuteron. From one of the sum rules, the ω-ϕ mixing angle is estimated. The results are then briefly discussed. (auth)

Strong (Baryon No. = 1)

Refer also to abstract 33750.

33699 (JINR-P1-3375) ISSLEDOVANIE VZAIMODEISTVIYA K_L^0-MEZONOV SO SREDNEI ENERGIEI 120 MeV S YADRAMI Ar, Cu, Pb. (Investigation of the Interaction of 120 MeV K_L^0-Mesons With Ar, Cu, Pb Nuclei). Vardenga, G.; Zhuravleva, M.; Kotlyarevskii, D.; Novikov, V.; Okonov, E.; Takhtamyshev, G.; Chkhaidze, L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 14p. (In Russian). Dep.

The production cross sections of $\Lambda^0(\Sigma^0)$-hyperons in the interaction of K_L^0-mesons (with an average energy of 120 MeV) with Ar, Cu, Pb nuclei are determined to be: $\sigma_{Ar} = (44 \pm 15)$ mb, $\sigma_{Cu} = (58 \pm 10)$ mb, $\sigma_{Pb} = (225 \pm 36)$ mb. It is shown that the obtained momentum and angular distributions of Λ^0-hyperons produced agree well with the cascade particle interaction model. (auth)

33700 EXPERIMENTAL TEST OF THE PION–NUCLEON FORWARD DISPERSION RELATIONS AT HIGH ENERGIES. Foley, K. J.; Jones, R. S.; Lindenbaum, S. J.; Love, W. A.; Ozaki, S.; Platner, E. D.; Quarles, C. A.; Willen, E. H. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Rev. Lett., 19: 193-8(July 24, 1967). (BNL-11421).

A critical test of the pion-nucleon forward dispersion relations up to the highest energies practical at the alternating-gradient synchrotron involving a precise measurement of both the real and imaginary parts of the π-N scattering amplitude is described. It is found that the predictions of the π-N forward dispersion relations are in good agreement with the experiment up to at least 20 BeV/c. (auth)

33701 TESTS OF NEW π-N SUPERCONVERGENT DISPERSION RELATIONS. Liu, Yu-chien; Okubo, S. (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Phys. Rev. Lett., 19: 190-2(July 24, 1967). (UR-875-204).

A new type of superconvergent sum rules for π + N scattering amplitudes is derived and compared with experiments. The sum rules are essentially superconvergent dispersion relations, with only one essential difference in that they contain integrals of both the real and the imaginary parts of the scattering amplitude. (J.F.P.)

33702 EQUAL-TIME COMMUTATION RELATIONS FOR COMPOSITE FIELDS AND STRONG-INTERACTION SUM RULES. Fayyazuddin (Univ. of Chicago); Riazuddin. Contract AT(11-1)-264. Ann. Phys. (N.Y.), 43: 228-41(June 16, 1967). (COO-264-364; EFINS-67-1).

By using the equal-time commutation relations between composite fields proposed by Delbourgo, Salam, and Strathdee, together with Bargmann–Wigner type of equations, results are derived for the $\rho\pi\pi$ and ρNN coupling constants and sum rules for s-wave pion-nucleon scattering. Under certain approximations, it is shown that the N*N transition magnetic moment is given by $\mu^* = (1.6)\ \frac{2}{3}\sqrt{2}\mu_p$ as compared with the value $\mu^* = (1.28 \pm 0.02)\ \frac{2}{3}\sqrt{2}\mu_p$ obtained by Dalitz and Sutherland. (auth)

33703 THE POSSIBILITY OF CHECKING THE $\Delta T = \frac{1}{2}$ RULE IN REACTIONS OF SINGLE PRODUCTION OF STRANGE PARTICLES. Belavin, A. A.; Kobzarev, I. Yu. JETP Lett. (USSR) (Engl. Transl.), 5: 226-8(Apr. 15, 1967).

Translated from Zh. Eksp. Teoret. Fiz., Pis'ma Redakt., 5: 277-9(Apr. 15, 1967).

Attention is called to the fact that interactions with single production of strange particles and formation of the isobar Δ (1246) and (or) isoscalar mesons may turn out to be more convenient for checking the $\Delta T = \frac{1}{2}$ rule than previously proposed interactions. Relations, resulting from the $\Delta T = \frac{1}{2}$ rule, between the cross sections for the proposed interactions are presented. (J.F.P.)

33704 SCATTERING AMPLITUDE IN REGGE POLE THEORY IN THE KINEMATIC REGION OF THE BACKWARD PEAK π-N. Thibault, N. (College de France, Paris). Nuovo Cim. (10), 50A: 135-51(July 1, 1967). (In French).

It is shown that, by means of a suitable transformation in the complex l-plane, it is possible to obtain a formulation of the Regge-pole theory in the u-channel, which is convenient for the kinematical region of backward π-N scattering. The present work differs from previous attempts by a careful examination of the mathematical consequences induced by these unusual values of kinematical parameters. It is assumed that the exchange of $N\frac{3}{2}$ and nucleon trajectories are the main contributions to the amplitudes in π^-p and π^+p backward scattering respectively. It is discussed how the experimental predictions depend on the behavior of the Regge trajectories near u = 0. Whatever this behavior may be, the experimental results already obtained show that the residues of both Regge poles vanish at u = 0. The probable nonshrinking (or very weakly shrinking) of the peak, not yet firmly ascertained, is related to special entire values of the ordinates of Regge trajectories at u = 0. (auth)

33705 INDUCED REPRESENTATIONS OF STRONG COUPLING GROUPS. Cook, T. (Univ. of Wisconsin, Madison. Argonne National Lab., Ill.); Sakita, B. J. Math. Phys. (N. Y.), 8: 708-13(Apr. 1967).

Mackey's method of induced representations is applied to the strong coupling group G = K · T, where K is compact and T is Abelian, to obtain the general irreducible representations. The form of the meson-isobar-isobar coupling is obtained by reducing these, with the use of the Peter–Weyl theorem, to irreducible representations of the compact subgroup K. The results are applied to the cases: pseudoscalar octet mesons, $K = SU_2 \otimes SU_3$, $T = T_{24}$, and SU_6 35-plet mesons, $K = SU_6$, $T = T_{35}$. Explicit representations are obtained which are consistent with mass formulas $M \propto I_2(\mu) - \frac{1}{6}J(J+1)$ and $M \propto G^2$ in the respective cases. (auth)

33706 FORM FACTORS AND THE ABSORPTIVE ONE-PION-EXCHANGE MODEL. Yock, P. C. M.; Gordon, David (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 157: 1362-71(May 25, 1967). (MIT-2098-258).

The one-pion-exchange model, corrected for absorption in the initial and final states, is examined for those two-body reactions involving the production of high-spin particles. It is found that the inclusion of form factors brings the theory into agreement with experiment. By consideration of a number of reactions, explicit expressions for the $N\pi N^*(1238)$ and $\pi\pi f$ vertex function form factors are obtained. It is shown that these form factors do not require the existence of any as yet undiscovered mesons. Implications of these form factors in two-pion-exchange calculations are also discussed. (auth)

33707 INTERFERENCE EFFECTS IN ρ-MESON DECAY. Griffiths, David (Johns Hopkins Univ., Baltimore); Jabbur, R. J. Phys. Rev., 157: 1371-5(May 25, 1967).

The asymmetry in the decay of the ρ meson produced in the reaction $\pi^- + N \rightarrow \rho + N$ is studied in terms of interference effects due to the coherent production of pairs of pions in other isospin states. The hypotheses of a ρ-ϵ (s-wave, T = 0 pion pair) interference, a constant π-π phase shift, and other mechanisms are studied. The theoretical predictions resulting from these models are

compared with recent experimental results on the decay of the neutral and charged ρ meson. (auth)

33708 ANALYSIS OF 3-BODY ANGULAR MOMENTUM STATES IN $\pi N \rightarrow \pi\pi N$. Namyslowski, J. M. (Stanford Univ., Calif.); Razmi, M. S. K.; Roberts, R. G. Phys. Rev., 157: 1328-43(May 25, 1967).

A relativistic formalism for analyzing 3-body angular momentum states in production processes is presented in detail together with examples of several processes $\pi N \rightarrow \pi\pi N$ at different energies below 1 BeV. In the final state either one or several 3-particle angular momentum states, belonging to only one complete set of states are assumed. This enables different partial-wave transitions to be distinguished, and the analysis to be made in a systematic way. As a dynamical assumption the isobar model is used, and only a minimum number of transitions are allowed in order to minimize the number of free parameters. The formulas are written in terms of variables used in the Faddeev theory with separable approximation; thus they can be applied for testing solutions of the Faddeev equation. (auth)

33709 FORMATION OF RESONANCES IN π^+p COLLISIONS AND REGGE POLES. Kaidalov, A. B.; Karnakov, B. M. JETP Lett. (USSR) (Engl. Transl.), 5: 284-6(May 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktisiyu, 5: 344-8(May 1, 1967).

The energy dependence of the elements of polarization density matrices of the resonances produced in the interactions: $\pi^+ + p \rightarrow \omega^0 + N_{33}^{*++}$, $\pi^+ + p \rightarrow \pi^0 + N_{33}^{*++}$, $\pi^+ + p \rightarrow \rho^0 + N_{33}^{*++}$, and $\pi^+ + p \rightarrow \rho^+ + p$ and the cross sections for these interactions at different energies are considered on the basis of the hypothesis of several Regge poles. The assumptions made and the method of calculation are described with the first interaction as an example. Final results are given for the remaining interactions. (J.F.P.)

33710 ON A POSSIBLE (7/2)-OCTET. Kostyrko, I. I. (Inst. of Mathematics, Kiev). Ukr. Fiz. Zh., 12: 466-7(Mar. 1967). (In Russian).

The mass and other quantum characteristics of not yet discovered resonances with $7/2^-$ spin and parity were calculated using the method previously developed by the author (Ukr. Fiz. Zh. 11, 20, 1966) and taking into account experimental data concerning baryon resonances $N_5^*(2190)$ and $Y_0(2120)$ with $7/2^-$ spins and parities. The work is confined to the case in which $(7/2^-)$ multiplet is an octet. (R.V.J.)

33711 METHOD OF CALCULATING CHARGE BRANCHING RATIOS SUGGESTED BY THE STATISTICAL MODEL. Zalewski, K.; Danysz, J. A. (CERN, Geneva). Nucl. Phys., B2: 249-62 (1967).

The problem of calculating charge branching ratios for multiple production processes is discussed. A method of calculation suggested by the statistical model is described and applied to π^+p interactions at 4 GeV/c, $p\bar{p}$ annihilations at 3 GeV/c and K^+p interactions at 3.0, 3.5 and 5.0 GeV/c. The results are compared with experiment. (auth)

33712 RANDOM-PHASE K MATRIX APPROACH TO ABSORPTION IN PERIPHERAL INTERACTIONS, THE ρ_0-NUCLEON CROSS SECTION, AND SOME LEADING α^3 CONTRIBUTIONS TO g-2 FOR THE MUON. Trefil, James Stanley. Stanford, Calif., Stanford Univ., 1966. 172p.

Thesis.

Three separate problems are presented. In the first, initial- and final-state corrections to single-particle exchange amplitudes are studied. Two multichannel K-matrix formalisms, which are expected to be valid for different energy regions, are developed by means of a random phase approximation, and two similar absorption formulas are derived. Both reduce to the Gottfried-Jackson form for weak absorption, but give more absorption in the lower partial waves. The models are applied to the reactions $\pi^+ + p \rightarrow \pi^+p$ for scattering angles near 180°, and to the reaction $\pi^-p \rightarrow \pi^0n$ for small momentum transfer. The increased absorption makes it possible to fit the data in the 4-10 BeV/c region by an arbitrary choice of absorption parameters. In the second the electromagnetic contributions to the magnetic moment of the muon is calculated to order $[(\alpha/\pi)^3 \ln (m_\mu/m_e)]$. It is found that these contributions tend to cancel each other, so that the coefficient of $(\alpha/\pi)^3$ in the muon magnetic moment must be of order unity. Possible effects of strong and weak interactions are discussed, and are found to be larger than the electromagnetic contributions by a factor of from 3 to 5. Applications of the results of precision measurements of the muon g-2 to the investigation of the validity of quantum electrodynamics, to the search for an intermediate vector boson, and to other modifications of existing theories are discussed. An estimate of the ρ_0-nucleon total cross section is obtained by looking at the dependence of $d\sigma/d\Omega$ (0) for the reaction $\gamma + A \rightarrow \rho_0 + A$ as a function of atomic number. By using a simplified eikonal approximation, one can estimate the mean free path of the ρ_0 in nuclear matter, and hence estimate the total ρ_0-nucleon cross section. It is found that $60 \leq \sigma_{\rho N} \leq 90$ m. b. at 3.3 BeV/c. (Disser. Abstr.)

33713 LOW ENERGY ASSOCIATED PRODUCTION: $\pi^- + p \rightarrow K^0 + \Lambda$. Hoffman, Herbert Saul. Waltham, Mass., Brandeis Univ., 1966. 84p.

Thesis.

The process $\pi^- + p \rightarrow K^0 + \Lambda$ is studied near threshold by means of a resonance model based on the Cini-Fubini approximation using only known resonances. Thus the only term contributing an imaginary part of the amplitude is the $N^*(1688)$ T = 1/2, F 5/2 resonance. Reasonable agreement with the total cross-section and angular distribution data is obtained, but the predictions for the polarization are not satisfactory. It is concluded that either several small, complex amplitudes make important contributions to the polarization, or that there are other large partial waves in addition to the F 5/2 resonance. It may be difficult to distinguish between these two possibilities within the framework of this or other conventional resonance models. (Disser. Abstr.)

33714 DISPERSION THEORY OF THE FINAL STATE INTERACTION IN $\pi + N \rightarrow N + \pi + \pi$. Li, Yuan. Bloomington, Ind., Indiana Univ., 1966. 51p.

Thesis.

A phenomenological approach based on the extension of Chew-Low extrapolation theory is suggested for the application of dispersion theory to production processes. As a sample calculation the process $\pi + N \rightarrow \pi + \pi + N$, where the final state interaction is dominated by the ρ resonance, is considered. (TSS) (Disser. Abstr.)

33715 HIGH ENERGY ELASTIC SCATTERING. Armoudian, Garabed A. Baton Rouge, Louisiana State Univ., 1966. 59p.

Thesis.

The results of the partial wave analysis of π-p and p-p scattering in BeV energy ranges are reviewed, and it is pointed out that these results suggest a saturated Gaussian distribution of the inelastic collision matrix elements squared. The large angle p-p scattering is analyzed in terms of effective potentials. Analysis of Orear's empirical formula indicates the possible forms of the potentials: The potentials are characterized by their regularity at the origin. Similar potentials are derived from Markov's modified field theory. The results from the potential approach and Markov's theory are compared with experiment. Among the possible interaction models, the simplest one, scalar interaction gives the best result in both cases. From such analysis a semi-empirical formula is obtained which reproduces the experimental results very precisely. Physical interpretations of Markov's theory are also discussed. (Disser. Abstr.)

Strong (Baryon No. ≥ 2)

33716 INTERPRETATION OF HIGHLY INELASTIC PROTON-PROTON INTERACTIONS AT 10, 20, AND 30 GeV/c. Anderson, E. W.; Collins, G. B. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 19: 201-5(July 24, 1967). (BNL-11229).

A phenomenological analysis of the proton spectra resulting from inelastic proton-proton interactions is presented which suggests the existence of a bremsstrahlung-type process of pion production for highly inelastic collisions. A relation $\bar{n} = p_p^* \sin\theta^*/0.4$ is found between the implied average number of produced pions $\bar{n}$, the cm angle of scatter of the proton θ^*, and the cm incident-proton momentum p_p^*. A simple expression for the differential cross section for secondary protons yields excellent agreement with data over a wide range of angle, momenta, and incident-proton momenta. (auth)

33717 p-p SCATTERING AT 90° AND HADRONIC STRUCTURE OF THE PROTON. Islam, M. M.; Rosen, Joe (Brown Univ., Providence). Contract AT(30-1)-2262. Phys. Rev. Lett., 19: 178-80(July 24, 1967). (NYO-2262TA-152).

The p-p differential scattering cross section at 90° and laboratory momentum 5-13.4 GeV/c is explained in terms of two optical potentials and distorted-wave Born approximation of the corresponding amplitudes. The radial dependence of these potentials indicates two hadronic density distributions of the proton of root-mean-square radii 0.40 and 0.26 F. (auth)

33718 EXCITED-DROPLET MODEL FOR $pp \rightarrow pN_3^*$ AT HIGH ENERGIES. Arnold, Richard C. (Argonne National Lab., Ill.). Phys. Rev., 157: 1292-5(May 25, 1967).

A surface-excitation droplet model for N_3^* production in pp collisions at high energy and small momentum transfer is proposed which explains the Δ^2 dependence of the first two observed $I = 1/2$ isobars. (auth)

33719 SYSTEMATIC INVESTIGATION OF ULTRAHIGH-ENERGY INTERACTIONS. I. Yamada, S.; Koshiba, M. (Tokyo Univ.). Phys. Rev., 157: 1279-87(May 25, 1967).

Nuclear interactions in the energy range of 1000 GeV are studied by means of a large nuclear-emulsion stack. Particular emphasis is placed on collecting the samples of jets in an unbiased way, as well as on estimating the primary energy with better accuracy. For this purpose families of interactions initiated by heavy primary cosmic-ray particles are analyzed. A slightly modified Castagnoli method was applied to each family of jets to estimate the incident energy per nucleon. The method also enables one to select the quasimonoenergetic nucleons. The distribution of K_{ch}, the fraction of the primary energy imparted to the charged secondaries, is obtained from the interactions caused by the quasimonoenergetic nucleons. The arithmetic mean of K_{ch} is 0.28. The mean transverse momentum of the nucleons which have interacted in the parent collision is estimated to be $0.5_2 \pm 0.2$ GeV/c. (auth)

33720 NUCLEON–NUCLEON ELASTIC SCATTERING AMPLITUDES. Golovin, B. M.; Rozanova, A. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 1283-5(June 1967). (In Russian).

The coefficients of the pp elastic scattering, pp scattering without Coulomb interaction and np scattering amplitudes are calculated on the basis of the phase-shift analysis of the elastic pp and np scattering data at the energies 23, 40, 52, 68, 95, 147, 210, 310, 400 and 630 MeV. Some features are indicated concerning the pp scattering amplitude with and without Coulomb interaction. Data concerning the spin independent terms in the pp scattering without Coulomb interaction and np scattering amplitudes are compared with the theoretical predictions based on dispersion relations. (auth)

33721 RELATIVISTIC NUCLEON–NUCLEON INTERACTIONS. Green, A. E. S.; Sawada, T. (Univ. of Florida, Gainesville). Nucl. Phys., B2: 267-81(1967).

One-boson-exchange interactions are derived for pseudoscalar (P), vector (V), scalar (S), axial vector (A) and anti-symmetric tensor (T) mesons. The Schrödinger-Pauli limit is obtained for a general combination of such Diracian OBE interactions. Besides the static terms, the reduced interactions contain relativistic central, spin-spin, tensor, spin-orbit and velocity-dependent terms as well as velocity-dependent, tensor operators. The relativistic interactions V_p and $V_v + V_s$ are pursued in detail. Singularity difficulties are dealt with by using "regularized" fields. The phase shifts for N-N scattering are calculated for a purely relativistic model with two adjustable constants and a "broken" model with eight. The fits to the experimental phase shifts are presented. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 33952.

33722 APPROXIMATE SYMMETRIES AND PARTICLE CLASSIFICATION. Diu, B. (CERN, Geneva). J. Phys. (Paris), Colloq., 27: C4.23-39(Nov.-Dec. 1966). (In French).

An outline is given of the successes and difficulties encountered in applying the notion of approximate symmetry to high-energy physics, the interest being mainly focused on the resulting classification of particles. After some simple fundamental ideas have been briefly recalled, a more specific study of the SU(3) eightfold way, and then of SU(6) and the quark model, is undertaken. (auth)

33723 CONSTRUCTION OF THE IRREDUCIBLE REPRESENTATIONS OF SU_4. Sen, R. N. (Univ. of Naples. Istituto Nazionale di Fisica Nucleare, Naples). J. Math. Phys. (N. Y.), 8: 896-904(Apr. 1967).

The irreducible representations of SU_4 are explicitly constructed from those of SU_3 in the basis which is relevant for elementary particle physics. The technique seems to be applicable for the construction of the representations of SU_n from those of SU_{n-1} for any n. (auth)

33724 A SET OF HARMONIC FUNCTIONS FOR THE GROUP SU(3) AS SPECIALIZED MATRIX ELEMENTS OF A GENERAL FINITE TRANSFORMATION. Nelson, T. J. (Ames Lab., Iowa). Contract W-7405-eng-82. J. Math. Phys. (N. Y.), 8: 857-63 (Apr. 1967). (IS-1437).

A straightforward method for converting the commutation rules of the generators of a group into a set of differential equations is developed. The detailed development is applied to SU(3). Differential operators having the correct commutators are constructed and then combined into the quadratic and cubic combinations of the two Casimir operators. The solution of the resulting set of differential equations is the matrix element of a general finite transformation with the right-hand state specialized to the isotopic spin singlet. The set of such matrix elements is equivalent to the set of SU(3) harmonic functions derived by Beg and Ruegg. The isotopic spin-hypercharge content of the irreducible representations of SU(3) is deduced from the form of the matrix element, though prior knowledge of the fact that each irreducible representation of SU(3) possesses an isotopic spin singlet is assumed. (auth)

33725 CTP INVARIANCE OF THE S-MATRIX IN A THEORY OF LOCAL OBSERVABLES. Epstein, Henri (Inst. for Advanced Study, Princeton, N. J.). J. Math. Phys. (N. Y.), 8: 750-67(Apr. 1967).

In a theory of local observables as proposed by Haag and Araki, the assumptions which make possible a collision theory also guarantee the CTP invariance of the S-matrix. (auth)

33726 LIE ALGEBRA EXTENSIONS OF THE POINCARE ALGEBRA. Galindo, A. (Univ., Zaragoza, Spain). J. Math. Phys. (N. Y.), 8: 768-74(Apr. 1967).

The "linear" counterpart of the problem of analytic group extensions of the Poincaré group is presented in terms of the considerably simpler (but less general) analysis of Lie algebra extensions of the Poincaré algebra P. After easily proving with this technique that every C kernel (P,θ) has an extension and that every such extension is inessential, the problem of analyzing the central extensions of P is carried out with the well-expected result that every such extension is trivial. But contrary to some claims an example which explicitly shows an essential noncentral extension of P is exhibited. (auth)

33727 PECULIARITIES OF THE EIGHT-DIMENSIONAL SPACE. Gamba, A. (Univ., Genoa). J. Math. Phys. (N. Y.), 8: 775-81(Apr. 1967).

A mathematical review of the peculiar properties of the space of eight dimensions is presented with the view of possible applications in the study of symmetries of elementary particles. The discussion is self-contained. (auth)

33728 CANONICAL DEFINITION OF WIGNER COEFFICIENTS IN U_n. Biedenharn, L. C. (Duke Univ., Durham, N. C.); Giovannini, A.; Louck, J. D. J. Math. Phys. (N.Y.), 8: 691-700(Apr. 1967).

Two general results applicable to the problem of a canonical definition of the Wigner coefficient in U_n are demonstrated: the existence of a canonical imbedding of $U_n \times U_n$ into U_n^2 and a general factorization lemma for operators defined in the boson calculus. Using these results, a resolution of the multiplicity problem for U_3 is demonstrated, in which all degenerate operators are shown to split completely upon projection into U_2. (auth)

33729 DYNAMICAL REARRANGEMENT OF APPROXIMATE SYMMETRIES. Nakagawa, K. (Univ., Naples. Istituto Nazionale di Fisica Nucleare, Naples). Nuovo Cim. (10), 50A: 37-52(July 1, 1967).

An example of a combination of spontaneous and intrinsic breakdown of symmetry is studied. When the effect of spontaneous breakdown is much stronger than that of intrinsic breakdown, the original symmetry is replaced by a new symmetry and the symmetry transformation is mainly taken care of by the transformation of spinless boson. When the intrinsic breaking term becomes stronger, the symmetry transformation comes closer to its original form, while the spinless boson remains. The divergence of helicity current written in terms of physical field is obtained in the form effectively similar to PCAC. A possible application to the spurion theory of the weak phenomena is suggested. (auth)

33730 MECHANISM OF SPONTANEOUS SYMMETRY BREAKDOWN IN RELATIVISTIC FIELD THEORIES. Sen, R. N. (Univ. Naples. Istituto Nazionale di Fisica Nucleare, Naples. GNSM, Naples); Umezawa, H. Contract AF61(052)-826. Nuovo Cim. (10), 50A: 53-74(July 1, 1967).

The mechanism of spontaneous breakdown of continuous internal symmetries is studied in relativistic quantum field theories in which Coulomb-type potentials are not initially present. The crucial point is the analysis of the structure of the symmetry generators in terms of the physical (asymptotic) fields, which can be performed without solving the dynamical problem explicitly. Mathematically, spontaneous breakdown of symmetry is possible when the symmetry transformations are not required to be unitarily implementable in the physical Hilbert space. It is shown that failure of implementability results exclusively from linear contributions of massless spin-zero physical fields to the generators. The breakdown of symmetry is exhibited in an asymmetric

vacuum state; however, mass differences within multiplets of physical fields are found to be forbidden. Asymmetry of the vacuum is, in physical language, the result of Bose–Einstein condensation of massless, spinless physical bosons, which act as the source of spurions. (auth)

33731 GRAPHICAL METHOD FOR THE CROSSING MATRIX IN THE OCTET MODEL. Castel, B.; El-Baz, E.; Lafoucriere, J. (Univ., Lyon). Nucl. Phys., B2: 296-306(1967).

The graphical method previously used of CG coefficients of SU_3 is now applied to describe crossing matrices in the octet model. Useful relations about the crossing matrices previously derived mathematically by de Swart are now easily shown. Besides helping visualize the physical phenomena, this method gives an easy proof of a yet unproved equality which was noticed by de Swart. (auth)

33732 UNITARY REPRESENTATIONS OF GROUPS SO(p,q), SU(p,q). Nachtmann, Otto (Univ. of Vienna). Acta Phys. Austr., 25: 118-29(1967).

Unitary representations of groups SO(p,q), SU(p,q) are constructed by using several times the method of inducing a representation by a subgroup. To the irreducibility and equivalence of the representations only plausible arguments are given. The problem of reducing the representations of the noncompact groups with respect to the maximal compact subgroups is completely solved. (auth)

33733 ON SOME REPRESENTATIONS OF THE ANTICOMMUTATION RELATIONS. III. Cordesse, A.; Rideau, G. (Institut Henri Poincare, Paris). Nuovo Cim. (10), 50A: 244-55 (July 21, 1967).

Type III representations of the anticommutation relations were constructed using the infinite direct product of Hilbert spaces. The conditions are given for the equivalence or for the disjunction of two such representations. It is shown that most of these representations are disjoint. (auth)

33734 HEISENBERG ALGEBRA AND CONTRACTIONS OF THE ROTATION ALGEBRA. Yndurain, F. J. (New York Univ.). Nuovo Cim. (10), 50A: 308-12(July 21, 1967).

The contractions of the rotation algebra are described. A special singular one is analyzed; it yields the Heisenberg algebra. The unitary representation of the latter is obtained by contracting representations of the rotation algebra using Inönü and Wigner's trick. (auth)

33735 GENERAL TYPES OF HAMILTONIANS FOR PARTICLES OF ANY SPIN. Mathews, P. M.; Ramakrishnan, S. (Univ. of Madras). Nuovo Cim. (10), 50A: 339-48(July 21, 1967).

An explicit determination is made of four general classes of Hamiltonians possible for particles of spin s and mass as described by a Schrödinger equation invariant under Lorentz transformations and under T, C and P. Among these possibilities there is only one Hamiltonian which satisfies a regularity condition at the origin of momentum space; it has been considered earlier and found to be an adequate starting point for second quantization only in the half-integer spin case. This provides the motivation for explicit consideration of the other possibilities. (auth)

33736 LOCALITY OF INTERACTION AND PARAMETRIZATION OF HELICITY AMPLITUDES. Volkov, D. V.; Gur'ev, V. N. (Physical-Technical Inst., Kiev). Yadern. Fiz., 5: 1290-8(June 1967). (In Russian).

Transformation of helicity amplitudes for particles with arbitrary spin under the substitution $\sqrt{t} \to -\sqrt{t}$ is considered as well as the connection of this substitution with certain locality requirements. On the basis of the considered transformation properties, the parametrization of vertex functions is presented in terms of helicities of three particles that interact in the vertex. Some points concerning the connection of the parametrization of helicity amplitudes with a higher symmetry theory are considered. (auth)

33737 REPRESENTATION OF THE FINITE ROTATION MATRIX AS A SUM OVER CLEBSCH-GORDAN COEFFICIENTS. Marinov, M. S. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 5: 1321-3(June 1967). (In Russian).

The matrix that determines the transformation of the state vector with the angular momentum j is represented as a sum over the Clebsch–Gordan matrices. There are $2j + 1$ terms in this sum. Every coefficient in the sum is proportional to the spherical harmonics of the unit vector that specifies the rotation axis multiplied by the Gegenbauer polynomial of the $\cos \frac{1}{2}\Phi$ (Φ is the rotation angle). (auth)

33738 SPECIAL PERMUTATION INVARIANTS OF FOUR SU_3 OCTETS. Ahrens, Tino (Georgia Inst. of Tech., Atlanta). Phys. Rev., 157: 1458-9(May 25, 1967).

A simple proof is given that a biquadratic form of the octets exists which is a scalar under SU_3, an eigenvector of the permutation operator p_{13} (and p_{24}), and whose constituent quadratics transform like octet components. The form is given and so is another, subject only to the last two conditions. (auth)

Applications (Electromagnetic and Weak)

33739 PARTIAL SYMMETRY. Freund, Peter G. O. (Univ. of Chicago). Phys. Rev. Lett., 19: 189(July 24, 1967).

It is pointed out that the relation recently obtained by Schwinger for the weak $n \to p$ transition, based on the juxtaposition of chiral SU(3) and of SU(6) considerations, is easily understandable without referring to specialized partial symmetry arguments. (J.F.P.)

33740 T-ODD CORRELATIONS IN WEAK DECAYS AND ELECTROMAGNETIC PROPERTIES OF HADRONS. Khriplovich, I. B.; Okun, L. B. (Academy of Sciences, Moscow). Phys. Lett., 24B: 672-4(June 26, 1967).

The so-called T-odd correlations in leptonic decays of hadrons due to electromagnetic final state interaction were calculated. Analysis of these correlations is of interest since they form a masking background for the effects due to possible CP-violation. An accurate measurement of T-odd correlations in K^0_{e3}-decays would in principle allow one to determine the electrical radius of the π-meson and in $\Xi^- \to \Lambda e\bar{\nu}$-decays the magnetic moment of the $\Sigma\Lambda$-transition. However, to get this information the existing statistics of the decays should be increased by four orders of magnitude in the first case and by eight orders in the second case. (auth)

33741 TIME-REVERSAL NONINVARIANCE AND THE DECAY $\Sigma^+ \to p + \gamma$. Salzman, F.; Salzman, G. (Argonne National Lab., Ill. Univ. of Massachusetts, Boston). Nuovo Cim. (10), 50A: 75-88(July 1, 1967).

The introduction of an elementary electric-dipole moment interaction into the structure of weak interactions has previously been shown capable of accounting for the $K^0_2 \to 2\pi$ decay and of leading to nucleon electric-dipole moments $\sim 10^{-20}$ cm · e, almost as large as the present experimental upper limit on the neutron electric dipole. It is shown here that the same interaction should contribute substantially to the $\Sigma^+ \to p + \gamma$ decay amplitude, and is probably consistent with the restriction imposed on the amplitude by the experimental rate for this process. It is also shown that the unitarity contribution to this amplitude, which is due almost entirely to the decay mode $\Sigma^+ \to \pi + \mathcal{N}$, and which simulates the effect of the elementary T-noninvariant interaction, is substantial and will have to be included in any realistic analysis of the process. (auth)

33742 RELATIONS FOR THE N–N* WEAK FORM FACTORS FROM CURRENT ALGEBRA IN THE INFINITE-MOMENTUM LIMIT. Auvil, P. R. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 157: 1400-2(May 25, 1967).

The nucleon matrix elements of an "SU(2) ⊗ SU(2)" subalgebra of $U_6 \otimes U_6$ are considered in the infinite-momentum, nonzero-momentum-transfer limit. Only the N and N* intermediate states are retained. In this approximation the results of the dispersive approach are reproduced while also obtaining Oehme's equation which was derived for the zero-momentum-transfer case. (auth)

33743 CURRENT ALGEBRA AND THREE-BODY WEAK RADIATIVE DECAYS OF THE HYPERONS. Gupta, K. C.; Majumdar, Rabi; Tripathy, K. C. (Univ. of Delhi). Phys. Rev., 157: 1306-9(May 25, 1967).

The three-body weak radiative decays of the hyperons were studied within the framework of the SU(3) ⊗ SU(3) chiral algebra. Following the same procedure as used for nonleptonic hyperon decays, sum rules were obtained for the parity-violating case and, further, taking the pole model for the weak two-body vertex, decay rates for both parity-violating and parity-conserving cases were calculated in terms of S-wave nonleptonic hyperon decay parameters. The result for the $\Sigma^+ \to n + \pi^+ + \gamma$ decay agrees reasonably with the experimental value. (auth)

Applications (Strong)

Refer also to abstracts 33641 and 33735.

33744 SUM RULES FOR THE SPECTRAL FUNCTIONS OF SU(3) ⊗ SU(3). Glashow, S. L. (Harvard Univ., Cambridge, Mass.); Schnitzer, Howard J.; Weinberg, Steven. Phys. Rev. Lett., 19: 139-42(July 17, 1967).

The spectral-function sum rules are given for a general Lie algebra, and then applied to the vector and axial-vector mesons coupled to the currents of SU(3) ⊗ SU(3). (auth)

33745 SCATTERING AND INFINITE DIMENSIONAL SYMMETRY SCHEMES. Stern, J. (Czech Technical Univ., Prague). Czech. J. Phys., 17: 391-9(1967).

The recently proposed non-trivial binding of the Poincare group with internal symmetry groups, which leads to mass splitting without symmetry breaking, from the point of view of scattering. A very general realization is given of the corresponding infinite dimensional Lie algebra in the Fock space of asymptotic states built from two scalar nucleons. Assuming that the algebra describes the exact symmetry of the S-matrix it is concluded that no elastic NN scattering exists. (auth)

33746 0^+ MESONS IN THE 189- AND 405-PLETS OF SU(6). Enkovski, L.; Kukhtin, V. V. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 726-8(May 1967). (In Russian).

Mass relations for 0^+ mesons in the 189- and 405-plet of SU(6) group are derived taking into account mixing between different unitary multiplets with the same spins. Comparison with experiment is carried out. (auth)

33747 A NOTE ON THE 10^* AND 27 REGGE TRAJECTORIES. Di Vecchia, P.; Drago, F. (CNEN, Rome). Nuovo Cim. (10), 50A: 181-4(July 1, 1967).

It is shown that there are some reactions, experimentally accessible, for which it is possible to exchange in the crossed channel only 10^* and 27 trajectories. (L.B.S.)

33748 BROKEN U(8) AND $p\bar{p}$ ANNIHILATION AT REST. Nwachuku, C. O. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., 157: 1490-2(May 25, 1967). (IC-66/107).

The problem of $p\bar{p}$ annihilation at rest into two mesons, pseudoscalar-pseudoscalar (PP), pseudoscalar-vector (PV), and vector-vector (VV) mesons, is treated in detail in the framework of covariant $\bar{U}(8)$ theory. Second-order spurions of the form $q \otimes \bar{q}$, $\sigma_{\mu\nu} \times \sigma_{\mu\nu}$ are inserted into the $\bar{U}(8)$-invariant annihilation amplitude, breaking further the intrinsically broken $\bar{U}(8)$. The highlights of our predictions obtained from the input data (i) $A(\pi^+\pi^-) : A(K^+K^-) = 9:5$, (ii) $A(K^+K^-) : A(K^0\bar{K}^0) = 7:5$, and (iii) $A(\rho^0\pi^0) : A(\rho^0\eta^0) = 5:2$ are: (a) $A(K^+K^{*-}) : A(K^0\bar{K}^{*0}) = 4:-5$; (b) $A(\rho^0\pi^0) : A(K^+K^{*-}) = 3:1$; (c) $A(\rho^{s,0}\rho^{s,0}) : A(K^{*+}K^{*-}) = 2:1$; and (d) the nonexistence of sum rules hitherto predicted by $\bar{U}(12)$. These results are in good agreement with experiments. It is concluded that $\bar{U}(8)$ may be a better approximate symmetry for reactions than $\bar{U}(12)$. (auth)

33749 GROUP EMBEDDING OF SPACE-TIME AND INTERNAL SYMMETRY GROUPS. Doebner, H. D.; Hegerfeldt, G. C. (Philipps Univ., Marburg, Ger.). J. Math. Phys. (N. Y.), 8: 730-41(Apr. 1967).

An embedding of SU(2) and an internal symmetry group G into a larger group $\bar{G}$ containing SU(2) and G as subgroups is constructed for all G possessing a generalized spin-$\frac{1}{2}$ quark model. The starting point is a set of three mathematical conditions for the embedding group $\bar{G}$ which are derived from physically plausible assumptions. By group theoretical techniques due to Dynkin and Malcev, it is shown that the embedding group is already uniquely determined by the proposed conditions, with only one set of groups G for which two solutions are obtained. The results for G are given explicitly. Identifying SU(2) as covering of the rotation group, the spin extension $\bar{G}$ is enlarged to an embedding $\bar{G}_h$ of the homogeneous Lorentz group L_h and G. It is shown that $\bar{G}_h$ can also be obtained without using the spin extension. The minimal translation group which can be attached to $\bar{G}_h$ is calculated. The results are also taken over to the Budini-Fronsdal identification of SU(2). (auth)

33750 TESTS OF UNITARY SYMMETRY IN NUCLEI BY MESON-NUCLEUS REACTIONS. Kisslinger, L. S. (Brookhaven National Lab., Upton, N. Y. Western Reserve Univ., Cleveland). Phys. Rev., 157: 1358-61(May 25, 1967).

Tests of unitary symmetry in nuclei by coherent reactions leading to hypernuclei are examined. Starting from the two-particle amplitudes for elastic and strangeness-changing meson-baryon reactions, a pseudopotential is derived which couples the nucleus and hypernucleus channels. Using experimental cross sections, numerical estimates for various processes are made in order to appraise the feasibility of experiments, and it is found that experimental tests are possible with present techniques. (auth)

33751 THEORY OF HIGHER MESON STATES. Freund, Peter G. O. (Univ., Bologna. Univ. of Chicago). Contract AT-(11-1)-264. Phys. Rev., 157: 1412-15(May 25, 1967). (COO-264-337; EFINS-66-75).

The problem of classifying higher meson states with respect to the product $U(6) \times U(6) \times O(3)$ of the well-known hadron rest-symmetry group $U(6) \times U(6)$ and of the O(3) group generated by orbital angular momentum is investigated. It is shown that in the context of $U(6) \times U(6) \times O(3)$ symmetry, the total-cross-section relations $\sigma(K^+p) - \sigma(K^+n) = \sigma(pp) - \sigma(pn) = 0$ require the A_2 meson and therefore the whole nonet of observed 2^+ mesons to belong to the representation $(6,\bar{6}\ L = 1)$ of the group $U(6) \times U(6) \times O(3)$. The exchange degeneracy of the A_2 and ρ Regge trajectories $[\alpha_\rho(t) = \alpha_{A_2}(t)]$ and the apparently linear shape of $\alpha_\rho(t)$ are used to correlate the couplings of L = 0 and L = 1 mesons to hadrons. The masses (and some widths) of higher meson states on the $\rho - A_2$ trajectory and of their unitary partners are calculated. Their possible identification with the R, S, T, and U mesons is suggested. (auth)

33752 BOOTSTRAP AND THE SYMMETRY OF THE MESONS. Leung, Y. C. (Northeastern Univ., Boston). Phys. Rev., 157: 1351-7(May 25, 1967).

The problem of symmetry induction among a set of vector and pseudoscalar mesons was considered along the line of the Cutkosky model. The assumptions that enter into the model are discussed, and it is shown that within this set of assumptions the model can be extended to induce higher symmetry of the type commonly known as SU(6) by explicitly enumerating the spin and orbital components of the particles in a nonrelativistic way. It is found that, within the bootstrap hypothesis, an extension can be achieved only if the internal symmetry group is a unitary group, SU(m), and the extended group is SU(2m). On the other hand, if the internal symmetry group is either an orthogonal group or symplectic group, no such extension is possible. If the internal symmetry group is a simple Lie group—for example, SU(3)—the concept of unitary parity (the analog of G parity) is found to be incompatible with SU(6), i.e., they are mutually exclusive. (auth)

33753 LIE GROUP OF THE STRONG-COUPLING THEORY. III. DYNAMICAL GENERATION OF EXTRA INTERNAL SYMMETRY FOR A CLASS OF REPRESENTATIONS. Babu, P.; Rangwala, A.; Singh, Virendra (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 157: 1322-6(May 25, 1967).

The strong-coupling dynamics, with isospin $SU(2)_I$ as the given internal symmetry group, leads to the generation of a larger internal symmetry group $SU(2)_{I_1} \otimes SU(2)_{I_2}$ ($I_1 + I_2 = I$) for the hyperon isobar-pion coupling constants, the hyperon isobar series having isospin-spin $I = J \pm \frac{1}{2} = 0, 1, 2, \ldots, \infty$. In this connection, a "modified contraction" method is described for constructing the irreducible representations of the strong-coupling group $\mathcal{Z} = [SU(2)_I \otimes SU(2)_J] \times T_3$, which starts from the "uncontracted" group $SU(2) \otimes SU(4)$ and provides a transparent formulation of the dynamical generation of extra symmetry for a class of irreducible representations of group $\mathcal{Z}$. One more method for constructing the representations of the group $\mathcal{Z}$ is also described which starts from a knowledge of the irreducible representations of inhomogeneous Euclidean group in four dimensions. (auth)

33754 $\Delta S = 0$ PARTIALLY CONSERVED AXIAL-VECTOR CURRENT AND SU(3) COUPLING CONSTANTS. Olesen, P. (Univ. of Copenhagen). Phys. Rev., 157: 1296-1305(May 25, 1967).

The meaning of the partially conserved axial-vector current (PCAC) hypothesis for the $\Delta S = 0$ current is investigated. It is shown that PCAC for the $\Delta S = 0$ current is not in good agreement with various semiphenomenological information. A new formulation of PCAC is given; the main point is that PCAC is valid (as an operator equation) only in the exact SU(3) limit. It is shown that this form of PCAC is a consequence of field theory (and rather weak dynamical assumptions) for matrix elements between states with two photons and the vacuum state. It is also found that in a mass-degenerate SU(3) world, the strong-interaction mixing parameter α_s can be expressed in terms of the weak-interaction mixing parameter α_W. Using $0 \leq \alpha_s \leq 1$, one finds that $0.145 < \alpha_W < 0.855$ (if the baryon masses are different) so that the allowed range for α_W is somewhat restricted by the baryon mass differences. Inserting a recent value for α_W in the formula for α_s, one obtains $\alpha_s = 0.733 \pm 0.018$, in excellent agreement with other recent determinations of αs. (auth)

33755 MIXING IN THE 189- AND 405-PLET OF SU(6). Enkovski, L.; Kukhtin, V. V. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 360-7(Mar. 1967). (In Russian).

The decomposition of the 189-plet and 405-plet of SU (6) into irreducible multiplets of its subgroups $SU(3) \otimes SU(2)$ and $SU(4) \otimes SU(2)$ is considered. The values of the mixing coefficients between different unitary multiplets with the same spin and relations between constants of decay of the type $0^+ \to 0^- + 0^+$ and $1 \to 0^- + \gamma$ are derived for mesons in the 189-plet. (auth)

33756 REMARK ON APPROACH TO THE PROBLEM OF COUPLING OF POINCARE GROUP AND AN INTERNAL SYMMETRY GROUP. Kolom'shchev, V. I. (Inst. of Mathematics, Kiev). Yadern. Fiz., 5: 1303-5(June 1967). (In Russian).

It is shown that there is no mass splitting among particles of

the same unitary multiplet of SU(3) in the approach of Ottosson et al. (Phys. Rev., 137: B658 (1965)), if an additional requirement is made on the generators H_1 and H_2 of the internal symmetry group, commuting with the generators of the Poincaré group, to belong to the SU(3) subalgebra of the Lie algebra of the internal symmetry group. Without this requirement a new classification of particles, principally different from that of SU(3) scheme, is required in this approach. In this case mass splitting will naturally have nothing in common with the familiar Gell-Mann–Okubo mass relations. (auth)

33757 BARYON–BARYON INTERACTIONS AND COLLINEAR SYMMETRIES. Vinternitts, P.; Kasymzhanov, M. A.; Makarov, A. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 1306-11(June 1967). (In Russian).

Relations following from collinear symmetries are obtained for the total cross-sections in definite spin states in the elastic baryon-baryon scattering. The construction of transition amplitude is considered for the collinear production of baryon resonances and relations are obtained between various polarization parameters. (auth)

33758 MAGNETIC MOMENTS OF THE BARYONS. Dunn, William Arthur. Evanston, Ill., Northwestern Univ., 1966. 40p.

Thesis.

Based on the assumption of exact SU_3 symmetry for the strong interactions, Coleman and Glashow have shown that all of the magnetic moments of the baryons may be expressed in terms of the magnetic moments of the proton and neutron. An investigation is made of how these predictions may be altered in the face of the broken SU_3 symmetry realized in nature. To this end, it is assumed that the various baryon magnetic moment form factors satisfy unsubtracted dispersion relations. Through a number of approximations, convenient expressions are developed for the baryon form factors which allow one to express the various magnetic moment ratios as functions of the pseudoscalar meson masses, the coupling constants γ_{Vpp} and $\gamma_{B\bar{B}p}$ and also a normalization parameter, t_0. Although the vector mesons are included in the calculation, the moment ratios turn out to be independent of their masses. Under various assumptions concerning the deviations of the couplings from exact SU_3 symmetry, the expected values of the anomalous magnetic moment ratios, μ_n/μ_Λ, μ_{Σ^+}/μ_p, and $-\mu_{\Xi^-}/(\mu_p+\mu_n)$ are calculated. It is found that the total magnetic moment of the Ξ^- is relatively insensitive to the various assumptions and is in moderately good agreement with the predictions of SU_3. The same is true, but to a lesser extent, of the total magnetic moment of the Σ^+. It is found that the A magnetic moment is the most sensitive to the assumptions, but the experimental evidence is so uncertain that one cannot, with confidence, rule out any of the assumptions as being incompatible with the experiments. The most remarkable feature of the calculation is that, in the face of mass splittings of several hundred percent and assumed deviations of the couplings of 50% or larger, the model is in as "good" agreement as it is with the predictions of exact SU_3. This suggests that the Coleman-Glashow predictions may rest on a much firmer footing than one may have expected from their method of derivation. (Disser. Abstr.)

33759 REGGE POLES AND π-p SCATTERING AT HIGH ENERGIES. Weinreb, Michael Philip. Waltham, Mass., Brandeis Univ., 1966. 103p.

Thesis.

π-p elastic scattering at high energies in the forward direction is analyzed in terms of a Regge one-pole model. Following the method of Lovelace, the dominant trajectory is obtained by comparing the Regge one-pole form with the π-p angular distribution data. The behavior of the trajectory in the complex angular momentum plane is shown to be independent of the functional form of the trajectory, as long as the trajectory is required to be analytic as a function of the momentum variable with the exception of a right hand cut along the real axis. In the above analysis the residue at the Regge pole is assumed to be independent of the momentum variable. A more general method of determining the leading trajectory is then employed, which allows the residue to exercise its considerable dependence on the momentum variable. This trajectory leads to better fits to the angular distribution data, and it accounts for the celebrated shrinkage behavior of the cross sections with increasing energy. In the crossed $(\pi-\pi)$ channel this trajectory leads to no resonances at all in the D-wave. Finally, the ρ and P′ trajectories, whose contributions are thought to lead to the small observed deviations from Regge one-pole behavior, are discussed. (Disser. Abstr.)

Quantum Field Theories

33760 INTERACTIONS OF MASSLESS SPINORS IN TWO DIMENSIONS. Dubin, Daniel A. (New York Univ.); Tarski, Jan. Ann. Phys. (N.Y.), 43: 263-81(June 16, 1967).

The interaction of massless spinors with massive vector mesons ($m_0 > 0$) in two dimensions is investigated. (We call this model the vector meson model.) Two definitions of the current are considered, and operator solutions employing auxiliary free fields are constructed. However, the presentation is heuristic in part, and the problem of positive definiteness of the theory is left open. The limit $m_0 \to \infty$ is easily obtained; it yields the Thirring model. (This fact was expected on the basis of unpublished thesis of Wraith.) Some complications are indicated in connection with the limit $m_0 \to 0$ to the Schwinger model. (auth)

33761 Z = 0 AND COMPOSITENESS. Osborn, Hugh (London Univ.). Phys. Rev. Lett., 19: 192-3(July 24, 1967).

A distinction is drawn between the divergence of the canonical commutator for composite fields and the condition Z = 0 for equivalence of an elementary field theory to a composite theory. (auth)

33762 LOCAL FIELDS WITH THE WRONG CONNECTION BETWEEN SPIN AND STATISTICS. Streater, R. F. (Imperial Coll. of Science and Tech., London). Commun. Math. Phys., 5: 88-96(1967).

It is proved that there exist free field operators which satisfy local commutativity and which transform according to certain unitary representations of the homogeneous Lorentz group. The fields satisfy axioms similar to the Wightman axioms, and give rise to local algebras of observables obeying postulates similar to those suggested by Haag. They describe a tower of particles with spins $\frac{1}{2}$, $1\frac{1}{2}$, $2\frac{1}{2}$, ..., but commute at space-like separation, giving rise to Bose statistics for the particles. This shows that the well-known theorem on spin and statistics cannot be extended to general theories of local observables; it also shows that the assumptions made in "S-matrix theory" do not hold for the S-matrix of a theory of interacting infinite fields. (auth)

33763 REAL SPINOR FIELDS. Hestenes, David (Princeton Univ., N. J.). J. Math. Phys. (N. Y.), 8: 798-808(Apr. 1967).

The Dirac equation is expressed entirely in terms of geometrical quantities by providing a geometrical interpretation for the $(-1)^{\frac{1}{2}}$ which appears explicitly in the Dirac equation. In the modification of the Dirac electron theory which ensues, the $(-1)^{\frac{1}{2}}$ appears as the generator of rotations in the spacelike plane orthogonal to the plane containing the electron current and spin vectors. This amounts to a further "relativistic" constraint on the spinor theory and so may be expected to have physical consequences. It does not, however, conflict with well-substantiated features of the Dirac theory. (auth)

33764 CURRENT ALGEBRA AND GAUGE VARIANCE. Bell, J. S. (CERN, Geneva). Nuovo Cim. (10), 50A: 129-34 (July 1, 1967).

It is urged that the lesson of gauge invariance in quantum electrodynamics implies the irrelevance of "Schwinger term" difficulties in current algebra. The divergence equations of Veltman form the basis of a gauge-variation formalism in which these questions are avoided. (auth)

33765 NOTE ON THE INFRARED DIVERGENCE. Greco, M.; Rossi, G. (CNEN, Frascati, Italy). Nuovo Cim. (10), 50A: 168-75(July 1, 1967).

It is shown how the infra-red divergence can be eliminated in the matrix element, provided that physically true final states for an experiment involving creation and destruction of charged particles are used. (auth)

33766 MODIFIED CANONICAL FORMALISM. Kazes, E. (Pennsylvania State Univ., University Park). Phys. Rev., 157: 1309-11(May 25, 1967).

The possible substitutes for the canonical commutation relations which are consistent with microscopic causality and Lorentz invariance are obtained. The result is also valid if fields are treated as 3-dimensional distributions. (auth)

33767 EFFECT OF SELF-ENERGY TERMS IN THE BETHE–SALPETER EQUATION. Levine, M. J. (Univ. of California, San Diego, La Jolla); Wright, Jon; Tjon, J. A. Contract AT(11-1)-Gen-10. Phys. Rev., 157: 1416-20(May 25, 1967). (UCSD-10P10-18).

The Bethe-Salpeter equation is solved in the ladder-graph approximation to the ϕ^3 theory with the inclusion of certain self-energy diagrams. The self-energy graphs are included to force the resultant cross sections to satisfy the unitarity condition $\sigma_{total} \geq \sigma_{elastic}$. It is found that the inclusion of these effects can substantially change both the elastic and inelastic cross sections. (auth)

33768 PHOTON AS A COMPOSITE PARTICLE IN QUANTUM ELECTRODYNAMICS. Broido, Michael M. (Rutgers-The State

Univ., New Brunswick, N. J.). Phys. Rev., 157: 1444-7(May 25, 1967).

It has been claimed that quantum electrodynamics can be written in a form in which the photon appears as a bound state (of the electron and positron). This notion is examined in the light of recent attempts to describe bound states in field theory by the vanishing of wave-function renormalization constants. The conclusion is that even if the renormalization constant $Z_3 = 0$ to all orders of perturbation theory, the photon cannot be described as a bound state, because other necessary conditions are not satisfied. The argument is given (implicitly) in terms of Green's functions rather than fields. (auth)

33769 SEPARABILITY OF SCHROEDINGER AND KLEIN-GORDON EQUATIONS WITH A VECTOR POTENTIAL. Wu, A. C. T. (Univ. of Michigan, Ann Arbor). Nuovo Cim. (10), 50A: 333-8(July 21, 1967).

Necessary and sufficient conditions are given for separability of the Schrödinger equation with a vector potential. The physical meaning of the condition on the vector potential is visualized with the aid of gauge invariance. The analysis can be carried out formally for the Klein-Gordon case. (auth)

33770 SOME PROPERTIES OF THE QUASIPOTENTIAL FOR INTERACTING SPINOR FIELDS. Desimirov, G.; Mateev, M. (IAEA, Trieste, Italy). Nucl. Phys., B2: 218-24(1967).

The common structure of the quasi-potential for two interacting four-component spinor fields with equal masses is investigated. Within some limitations it is proven that a pole term exists in the coupling constant. (auth)

33771 FIELD THEORY FOR HIGHER SPIN. Tung, Wu-ki. New Haven, Yale Univ., 1966. 81p.

Thesis.

Starting from the physical single particle states, all covariant field operators that can describe a particle of nonzero mass m and arbitrary spin s are constructed. General covariant field equations for these fields are then derived which are readily generalizable to include interactions. These equations are shown to have very simple structure. They all follow directly from a Lagrangian. The long-standing difficulties associated with the troublesome "subsidiary conditions" in previous theories of this kind are therefore cleared. Among all the possible equations for a given spin there are always first-order equations involving field operators transforming as the $(s,0) \otimes (s \pm \frac{1}{2}, \frac{1}{2}) \otimes (\frac{1}{2}, s \pm \frac{1}{2}) \otimes (0,s)$ representations of the homogeneous Lorentz group. These equations reduce to the Dirac equation for $s = \frac{1}{2}$ and to the Kemmer equations for $s = 0$ and 1. The possibility of using this formalism as the basis for a quantized field theory of higher spin is discussed but not solved. (Disser. Abstr.)

33772 CONSTRUCTION OF QUANTUM FIELDS INTERACTING BY A CUTOFF YUKAWA COUPLING. Lanford III, Oscar Erasmus. Princeton, N. J., Princeton Univ., 1966. 217p.

Thesis.

The scalar Yukawa coupling with interaction Lagrangian $\lambda\psi^+\psi\phi$ between a Dirac field and a neutral scalar field is studied by using the interaction picture with cut-offs to construct the Heisenberg picture fields as operator-valued distributions on Hilbert space. Mass renormalization is investigated. It is shown that adjusting the bare masses gives rise to the same vacuum expectation values as adding mass renormalization counterterms to the interaction Lagrangian, i.e., that the renormalized and unrenormalized interaction pictures are equivalent. A nonperturbative prescription for mass renormalization is given, and it is shown that the boson mass renormalization can be carried out. (TSS) (Disser. Abstr.)

33773 INFRARED DIVERGENCES IN QUANTUM ELECTRODYNAMICS. Chung, Victor Kenneth. Berkeley, Calif., Univ. of California, 1966. 57p.

Thesis.

The infrared divergences of quantum electrodynamics are eliminated to all orders of perturbation theory in the matrix elements by an appropriate choice of initial and final soft photon states. The coherent state formalism of Glauber is used to parameterize these states. It is shown that the condition for the cancellation of the divergences requires that these states belong to representations of the canonical commutation rules which are unitarily inequivalent to the usual Fock representation. A comparison to lowest order is made between this treatment and the conventional treatment whereby the divergences are cancelled in the total cross section. (Disser. Abstr.)

Scattering Theory

Refer also to abstracts 33576 and 34065.

33774 (CERN-67-16) HIGH-ENERGY REACTIONS AND REGGE POLES. Chan, H. M. (European Organization for Nuclear Research, Geneva (Switzerland)). June 21, 1967. 50p. Dep.

The discussion of Regge pole theory for high-energy interactions is treated entirely from a phenomenological point of view. Examples, analogies, and plausible arguments are given to indicate why the Regge hypothesis was made. Then the experimental consequences of such a hypothesis are studied. Theoretical difficulties are avoided and experimental evidence is used for the justification or rejection of the hypothesis. (J.F.P.)

33775 QUANTUM HARMONIC OSCILLATOR IN THE PHASE REPRESENTATION AND THE UNCERTAINTY RELATION BETWEEN THE NUMBER OF QUANTA AND PHASE. Fain, V. M. Zh. Eksp. Teor. Fiz., 52: 1544-8(June 1967). (In Russian).

The operators for the number of quanta and the creation and annihilation operators are written down in the phase representation. A complete set of eigenfunctions of the Hamiltonian operator for an harmonic oscillator is found in this representation. The uncertainty relation between the phase and number of quanta is derived. The relation has the form (16'). (auth)

33776 INVESTIGATION OF THE HYPOTHESES OF KHURI'S THEOREM ON REGGE-POLE ASYMPTOTES. Jones, C. Edward; Teplitz, Vigdor L. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 19: 135-7(July 17, 1967). (MIT-2098-337).

The hypotheses of Khuri's theorem, which imply that asymptotes of Regge trajectories cannot be infinite, are studied. It is shown that the residue function $\beta(s)$ is expected to have an essential singularity at infinity and that $\alpha(s)$ may well have complex branch points, making Khuri's theorem consistent with infinite asymptotes. (auth)

33777 FORWARD PEAKS FROM THE EXCHANGE OF ODD-PARITY REGGE TRAJECTORIES. Sawyer, R. F. (Univ. of California, Santa Barbara). Phys. Rev. Lett., 19: 137-9(July 17, 1967).

It is shown that a parity-doubled (at $t = 0$), $I = 1$, odd-signature trajectory is favored by a simple dynamical mechanism. A set of experiments is described whereby one could settle decisively the question of which (if any) of the possible O(4) conspiracies at $t = 0$ is realized. (auth)

33778 ASYMPTOTIC RELATIONS BETWEEN THE TERMS OF ASYMPTOTIC EXPANSIONS OF CROSS PROCESS AMPLITUDES. Lomsadze, Yu.; Tokar, S. (Uzhgorod State Univ., USSR). Zh. Eksp. Teor. Fiz., 52: 1529-35(June 1967). (In Russian).

Improvements are introduced in the results of previous studies in which asymptotic relations between the amplitudes of various cross processes, binary as well as nonbinary, were obtained. Precisely, asymptotic (for $\omega \to \infty$ along the real axis) equalities between the moduli of not only the senior but of all following respective terms of the asymptotic expansions of the cross reaction amplitudes are deduced which are also valid in the most general case of arbitrary binary and nonbinary processes. (auth)

33779 EXPANSION APPROACH TO SCATTERING. Harris, Frank E. (United Aircraft Research Labs., East Hartford, Conn.). Phys. Rev. Lett., 19: 173-5(July 24, 1967).

An expansion method for calculating scattering phase shifts which avoids the difficulties of the variational methods of Hulthén and Kohn is given. The approach taken is one which seeks to use to advantage the singularity properties that adversely affect the Kohn method. As it stands it is applicable to compound targets, and it appears extendable to multichannel processes. (J.F.P.)

33780 SCATTERING FROM COULOMB-LIKE POTENTIALS WITHOUT DIVERGENCES OR CUTOFFS. I. FORMALISM: GENERALIZED LIPPMANN-SCHWINGER EQUATIONS. West, Geoffrey B. (Stanford Univ., Calif.). Contract AF 49(638)-1389. J. Math. Phys. (N. Y.), 8: 942-53(Apr. 1967).

A general method is presented whereby integral equations, which govern the solution to the radial Schrödinger equation, can be derived. The equations are quite flexible and can be arranged so as to define divergenceless iterative procedures. They are therefore particularly useful for Coulombic and singular potentials, neither of which is normally covered by the standard theory. The standard theory as applied to Coulombic potentials was carefully examined; this is generally characterized by logarithmic divergences. It is shown that the standard Lippmann–Schwinger equation is no longer applicable and must be replaced by the corresponding homogeneous integral equation. Furthermore, it is demonstrated that the T matrix, as conventionally defined, vanishes. Upon application of the generalized integral equation, a perturbative result for the

scattering amplitude is obtained without the appearance of divergences or cutoffs. In the case of a pure point Coulomb potential, this result agrees very favorably with the exact one. In the modified case, the expression, by virtue of the fact that it does not require knowledge of Coulomb wavefunctions, is much simpler for computational purposes than the standard expressions. One simple example of the application of this method to singular potentials is briefly discussed. (auth)

33781 GENERAL METHOD FOR THE INVERSE SCATTERING PROBLEM AT FIXED ENERGY. Sabatier, Pierre C. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). J. Math. Phys. (N. Y.), 8: 905-18(Apr. 1967).

A method for studying the inverse scattering problem at fixed energy is given; it enables one to get at a fairly large class of potentials $\mathscr{V}$. It is shown that the problem has in $\mathscr{V}$ an infinity of solutions, depending on an infinity of parameters. If the study is restricted to the potentials of $\mathscr{V}$ which can be continued as even analytic functions in a circle centered at the origin, the problem has only one solution. A linear approximation is given and is shown to yield inverse formulas of the Born approximation. For even potentials of $\mathscr{V}$, the relevance of this approximation is studied as follows: Comparison is made between a given static potential and the potential obtained from the scattering amplitude through the inverse formula. The standard deviation between these two potentials is shown to go to zero as the energy goes to ∞. Miscellaneous properties of potentials, wavefunctions, and Jost functions are given in the framework of this method. (auth)

33782 ANALYTIC CONTINUATION OF THE OFF-ENERGY-SHELL SCATTERING AMPLITUDE. Nuttall, J. (Texas A and M Univ., College Station). J. Math. Phys. (N. Y.), 8: 873-7(Apr. 1967).

It is shown that the two-body scattering amplitude $\langle k|T(E)|k'\rangle$ may be analytically continued in E through the physical cut into a region of meromorphy, provided that the potential satisfies certain requirements. The residue at a pole is a separable operator whose form agrees with previous work. The proof also demonstrates the existence of a region of meromorphy of $\langle k|T(E)|k'\rangle$ as a function of seven complex variables. (auth)

33783 EQUATIONS WITH CONNECTED KERNELS FOR N-PARTICLE T OPERATORS. Newton, Roger G. (Indiana Univ., Bloomington). J. Math. Phys. (N. Y.), 8: 851-6(Apr. 1967).

The Lippmann–Schwinger procedure for single particle scattering is generalized for the calculation of n-particle T matrices describing collisions of a particle with a bound state of (n−1) other particles. The relevant T operators are expressed in terms of resolvents of compact operators, the equations for which are uncoupled. The two-body interactions appear in the form of their T operators only. (auth)

33784 BOOTSTRAP PREDICTION OF SYMMETRY FOR A SOLUBLE STATIC MODEL. Cunningham, Andrew A. (Univ. of Adelaide). J. Math. Phys. (N. Y.), 8: 716-29(Apr. 1967).

The Huang–Low bootstrap criterion of self-consistency, in the form of Levinson's theorem, is imposed on the exact solutions of the two-channel Low equation with an arbitrary crossing matrix. It is found that this condition together with a number of dynamical conditions are sufficient to restrict the continuous crossing-matrix parameter to discrete values corresponding to an SU_2 symmetry. (auth)

33785 RELATION OF THE O(2,1) PARTIAL-WAVE EXPANSION TO THE REGGE REPRESENTATION. Boyce, J. F. (International Centre for Theoretical Physics, Trieste, Italy). J. Math. Phys. (N. Y.), 8: 675-84(Apr. 1967).

The general two-particle scattering amplitude is expanded in terms of partial waves corresponding to the crossed channel little group, O(2, 1). Under the assumption of square integrability over the group manifold, the invariance of the S matrix under the complex Lorentz group, which follows from the Bargmann–Hall–Wightmann theorem, enables this expansion to be identified with the Regge representation in the crossed channel, whenever no dynamical singularities occur to the right of Re $j = -\frac{1}{2}$. The identification requires the assumption of the fixed t dispersion relation necessary for the definition of the Regge representation. (auth)

33786 GENERALIZED FACTORIZATION THEOREM AND THE ASYMPTOTIC BEHAVIOR OF THE SCATTERING AMPLITUDE. Kawai, T. (Osaka City Univ.). Nuovo Cim. (10), 50A: 176-80(July 1, 1967).

In the description of coupled m (≥2)-channel scattering of scalar particles, the generalized factorization theorem is proved for the coefficients $\beta_{ij}(s)$ in the signature partial-wave amplitudes $F_{ij}(l,s) = B_{ij}(s)f(l,s) + f_{ij}(l,s)$. The asymptotic form of the scattering amplitudes, which is usually assumed in the proof of the generalized Pomeranchuk theorem, is derived directly from the analyticity in the l-plane. In order to see the meaning of the generalized factorization theorem, the factorization relation for the cross sections at high energy is derived in the case of this asymptotic form. (L.B.S.)

33787 CRITERION FOR THE POWER BEHAVIOR OF THE SCATTERING AMPLITUDE AT HIGH ENERGY. Bessis, D.; Kinoshita, T. (CERN, Geneva). Nuovo Cim. (10), 50A: 156-67(July 1, 1967).

Within the framework of axiomatic field theory, a necessary and sufficient condition was obtained for the existence of the limit of the quantity $\alpha(s,t) = \ln f(s,t)/\ln s$, $0 \le t < 4\mu^2$, when $|s| \to \infty$, $\epsilon < \arg s < \pi-\epsilon$, $\epsilon > 0$, where $f(s,t)$ is a crossing-symmetric elastic-scattering amplitude. It is found to be related to the existence of a certain mean of the phase of $f(s,t)$. When this mean does not exist, $\alpha(s,t)$ oscillates indefinitely as $|s|$ increases. However, the variation of $\alpha(s,t)$ with s is very slow, the "period" of oscillation being an extremely rapidly increasing function of s. This oscillation may also be present in $f(s,t)$ for physical values of s superimposed on the oscillations of shorter range. It seems very difficult to detect the existence of such a long-range effect experimentally. (auth)

33788 ON THE INTEGRAL EQUATIONS IN THE THEORY OF N PARTICLE SCATTERING. Yakubovskii, O. A. (Leningrad State Univ.). Yadern. Fiz., 5: 1312-20(June 1967). (In Russian).

The system of the Faddeev integral equations for the amplitudes of three particle scattering is generalized to the case of an arbitrary number of particles N. The equivalence of the corresponding homogeneous system to the Schroedinger equation is conserved in this generalization. (auth)

33789 THE CREATION OF BOUND STATES BY A YUKAWA POTENTIAL. Abbe, W. J. (Univ. of Michigan, Ann Arbor). Nuovo Cim. (10), 50A: 364-7(July 21, 1967).

In an attempt to better understand how the branch or collision points of trajectories disappear as the coupling constant increases, thereby producing bound states and resonances, the Schroedinger equation for the unit range attractive Yukawa potential $(-g^2e^{-r})/r$ is numerically integrated for real negative energy, and the trajectories that result from varying the coupling constant g^2 respectively through the values 0.025, 0.075, 0.08, 0.10, and 0.125 are shown. (L.B.S.)

33790 A METHOD FOR CALCULATING REGGE TRAJECTORIES NEAR THRESHOLD. Abbe, W. J. (Univ. of Michigan, Ann Arbor). Nuovo Cim. (10), 50A: 368-70(July 21, 1967).

A method for calculating Regge trajectories is presented, which converges quite rapidly in the neighborhood of $k^2 = 0$, and is incomparably better than the first determinantal approximation. By combining the two methods the entire trajectory can be traced out for Yukawa-type potentials. (L.B.S.)

33791 A SIMPLE METHOD FOR CALCULATING REGGE TRAJECTORIES. Abbe, W. J. (Univ. of Michigan, Ann Arbor). Nuovo Cim. (10), 50A: 355-7(July 21, 1967).

A relatively simple method is presented for calculating Regge trajectories using a generalization of the procedure for obtaining indeterminancy points. (L.B.S.)

33792 PERTURBATION METHOD FOR LOW-ENERGY SCATTERING FROM SINGULAR POTENTIALS. Stanciu, G. N. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Nuovo Cim. (10), 50A: 293-307(July 21, 1967). (LA-DC-8376).

A systematic iterative perturbation method for low-energy scattering from singular potentials is introduced and illustrated by numerous examples. The starting point of the perturbation method is a first-order nonlinear differential equation that occurs in the phase formulation of scattering theory. This equation is solved in a perturbation sense by splitting the domain of the equation into two pieces and solving the equation by a series expansion on one of the subdomains and a linearization on the other subdomain. The perturbation method has the advantage that the calculations are relatively easy to perform and the bases of the method are intuitively clear. (auth)

33793 ANALYTICITY OF FORWARD-SCATTERING AMPLITUDE IN EXTERNAL MASS. Jin, Y. S. (Brown Univ., Providence). Contract AT(30-1)-2262. Nuovo Cim. (10), 50A: 256-64(July 21, 1967). (NYO-2262TA-139).

The analyticity domain of the forward-scattering amplitude in the external mass is obtained. The dispersion relation for the off-mass-shell amplitude and the Jost-Lehmann-Dyson representation of the absorptive part were used. (auth)

33794 REDUCTION OF THE THREE-PARTICLE COLLISION PROBLEM TO MULTICHANNEL TWO-PARTICLE LIPPMANN–

SCHWINGER EQUATIONS. Alt, E. O.; Grassberger, P.; Sandhas, W. (Univ., Bonn). Nucl. Phys., B2: 167-80(1967).

Starting from Faddeev's theory, exact one-dimensional integral equations for the three-body scattering problem are derived. The task is accomplished by application of the Schmidt method (quasi-particle method). The equations, which are more practical than those of Faddeev, have the structure of multi-channel two-particle Lippmann-Schwinger equations. The generalized "potentials" occurring in them have to be calculated from two-dimensional integral equations, the iteration of which should rapidly converge in most cases of physical interest. Thus the approach admits the systematical application of the methods of perturbation theory to composite-particle scattering problems. To lowest order a result of Lovelace is reproduced. (auth)

33795 SYSTEMATICAL TREATMENT OF THE NONRELATIVISTIC N-PARTICLE SCATTERING PROBLEM. Grassberger, P.; Sandhas, W. (Univ., Bonn). Nucl. Phys., B2: 181-206(1967).

For the n-particle collision problem, integral equations are derived which have the form of two-particle Lippmann-Schwinger equations. This is achieved by applying a modified version of the Schmidt method (quasi-particle method). For this it is, in contrast to general belief, not necessary and not even useful to start from integral equations which have kernels connected in the n-particle space. Starting from Faddeev-type equations, the kernels of which are not connected in the general case, the method has the effect that two of the considered particles appear as one quasi-particle. Thus, repeating this procedure the general case is reduced step by step to a two-quasi-particle problem solvable by Lippmann-Schwinger-type equations. The generalized "potentials" occurring in these equations can be calculated by convergent perturbation series. The method described suggests also how perturbation theory can generally be incorporated in theories with strong interactions. (auth)

33796 HAAG'S THEOREM IN SCATTERING THEORY. Garczynski, W. (Univ. of Wroclaw). Nucl. Phys., B2: 207-17 (1967).

Haag's theorem is identified and rigorously proved within the scattering theory based on the Wightman axioms. (auth)

33797 CONVERGENCE OF PADE APPROXIMANTS FOR THE BETHE–SALPETER AMPLITUDE. Nuttall, J. (Texas A and M Univ., College Station). Phys. Rev., 157: 1312-16(May 25, 1967).

Some earlier work on the Bethe-Salpeter equation is extended to show that the sequence of [N,N] Padé approximants to tan δ_l converges to the correct result if the scattered particles are of equal mass. The proof includes a demonstration that the symmetrized kernel of the Bethe-Salpeter equation after a coordinate-space Wick rotation is L^2. An interesting connection between Padé approximants and the Schwinger variational principle is given. (auth)

33798 RENORMALIZED BORN APPROXIMATION. Ford, W. F. (Lewis Research Center, Cleveland). Phys. Rev., 157: 1226-7(May 25, 1967).

A well-known defect of the Born approximation is that it often yields cross sections correct in shape, but orders of magnitude too large. A method is suggested for renormalizing approximate wave functions so that their amplitude is correct, not asymptotically but at some other more appropriately chosen point. This leads to an expression for the T matrix which is independent of the over-all amplitude of the approximate function. The method is applied to a plane wave Born approximation and a simple distorted-wave Born-approximation calculation of scattering from a square well. The renormalized results are in excellent agreement with exact calculations. (auth)

33799 AMBIGUITIES IN THE SOLUTIONS OF PARTIAL-WAVE DISPERSION RELATIONS. Rasche, G. (Univ., Zurich); Woolcock, W. S. Phys. Rev., 157: 1473-86(May 25, 1967).

Partial-wave dispersion relations for s-wave amplitudes are studied in the approximation where the left-hand singularities are replaced by a finite sequence of poles. Conditions are obtained under which solutions are possible and it is found that when these are satisfied several classes of solutions are obtained, with different behavior in the high-energy physical region. The case of p-wave amplitudes is also discussed. (auth)

33800 METHODS FOR CONSTRUCTING INVARIANT AMPLITUDES FREE FROM KINEMATIC SINGULARITIES AND ZEROS. Fox, G. C. (Cavendish Lab., Cambridge, Eng.). Phys. Rev., 157: 1493-1502(May 25, 1967).

The work of Hara and Wang on the kinematic singularities of helicity amplitudes for particles with spin is extended to rederive the invariant amplitudes given by Hepp and Williams. Parity-conserving invariant amplitudes are given for reactions in which at most two particles have spin. (auth)

Particle Accelerators

Refer also to abstracts 32549, 32935, 33166, 33167, 33872, 33954, and 33963.

33801 (BNL–11144) LOW RIPPLE PULSED PHASED BACK POWER SUPPLY. Cassel, R. (Brookhaven National Lab., Upton, N. Y.). [nd]. 4p. (CONF-670307–58). Dep. CFSTI.

From National Particle Accelerator Conference, Washington, D. C.

One of the difficult engineering problems of high power pulsed power supplies is to produce a large output voltage range with a low ripple voltage. Phased back rectifier power supplies have sufficient voltage range but suffer from a large ripple content. Two methods for reducing the output ripple without the use of a filter are described. It also includes a nonsynchronous firing system for controlling the resulting rectifier. (auth)

33802 (DESY–67/15) EXPERIMENTE MIT DER SYNCHROTRONSTRAHLUNG. (Experiments With Synchrotron Radiation). Haensel, R.; Kunz, C. (Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik. Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1967. 83p. (In German). Dep.

A brief historical introduction is followed by an outline of the basics of synchrotron radiation theory; analytic formulas for the power distribution are given. A comparison is drawn between synchrotron radiation and radiations from other sources. Experimental tests of the theory are summarized. Several instrumental problems are outlined, which are peculiar to experimenting with synchrotron radiation in the far ultraviolet. Special attention is paid to solid-state problems in a summary of those experiments in which the synchrotron is employed as a radiation source. (auth)

33803 (LA–3699) CALIBRATION OF TANDEM ANALYZING MAGNET. Magee, Norman H.; Masterson, Thomas G.; Whetstone, Stanley L. (Los Alamos Scientific Lab., N. Mex.). Aug. 1966. Contract W-7405-eng-36. 19p. Dep. CFSTI.

A particle scattering method has been used to help establish the energy calibration of the analyzing magnet at the LASL tandem Van de Graaff. The method and experimental procedures are described in some detail and a fairly complete presentation of the results is given. A least-squares fit to a large number of values obtained for the magnet constant K {defined for protons by $f = K[E(1 + E/2M)]^{\frac{1}{2}}$} gives $K = (6.057 \pm 0.004) - (9 \pm 18)10^{-10}f$ in the proton energy range of 10 to 20 MeV. Although K is found to be approximately constant over the range of the measurements, the value obtained does not agree with the value, 6.065 ± 0.002, derived from precise measurements of the $^{27}Al(p,n)$ threshold at 5.797 MeV. (auth)

33804 (PPAD–620E) CONTROL OF THE BEAM SPILL AT THE PPA. Henness, J.; Kang, C. L.; Kirchgessner, J.; Riedel, J.; Shoemaker, F. C. (Princeton–Pennsylvania Accelerator, Princeton, N. J.). Apr. 27, 1967. Contract AT(30-1)-2137. 13p. (CONF-670307–57). Dep. CFSTI.

From National Particle Accelerator Conference, Washington, D. C.

The PPA machine operates on a 20 cycle per second machine rate and is not flat topped. Due to these two factors spill lengths in the region of 5 to 10 milliseconds are not only long but contain up to 10% energy modulations. Conversely short spills are those occurring in less than a few hundred microseconds. Another unusual feature of the PPA machine is the one to two nanosecond rf bunch width at spill time. This feature was inherent with the first spill techniques and has proven invaluable to experimenters doing time of flight measurements in neutral secondary beams and separating K's from π's. Consequently the preservation of the rf bunching during spill has become a prerequisite for any PPA spill system. Within this boundary condition only the following targeting techniques are feasible: moving targets, magnet steering, rf steering, and resonant blow-up. Each of these techniques is presently utilized by PPA with the first two being secondary controls and the next two being primary controls. (auth)

33805 (RHEL/R–129) THE WORK OF THE RUTHERFORD LABORATORY FROM 1ST OCTOBER 1964–31ST DECEMBER 1965. Walsh, T. R. (ed.) (Rutherford High Energy Lab., Chilton (England)). Jan. 1967. 125p. Dep. CFSTI. UK 15s. 0d.

The work of the following Divisions of the Rutherford High Energy Laboratory is reported in detail: High Energy Physics, Nimrod, Applied Physics, Proton Linear Accelerator, Engineering, Radiation Protection, and Administration. Lists of publications by the staff are included. Separate abstracts are prepared for the first four sections. (UK)

For abstracts of individual sections see: 32372 and 33806–33808.

33806 (RHEL/R–129, pp 11–44) HIGH ENERGY PHYSICS DIVISION. (Rutherford High Energy Lab., Chilton (England)).

Various elementary particle interaction experiments performed at NIMROD are described, and the operation and instrumentation for NIMROD are discussed. The development of wire spark chambers is also mentioned. (J.F.P.)

33807 (RHEL/R–129, pp 45–77) NIMROD DIVISION. (Rutherford High Energy Lab., Chilton (England)).

The discussion of the NIMROD accelerator includes its operation and development, the accelerated beam utilization, beam transport components, and the development of polarized proton targets. The experimental beam lines are also discussed. (J.F.P.)

33808 (RHEL/R–129, pp 97–106) PROTON LINEAR ACCELERATOR DIVISION. (Rutherford High Energy Lab., Chilton (England)).

Experiments performed using the proton linear accelerator are briefly described. These studies cover proton reactions with light and heavier nuclei. The operation and development of the proton linear accelerator are also discussed. (J.F.P.)

33809 (RHEL/R–144) THE WORK OF THE RUTHERFORD LABORATORY IN 1966. Telling, F. M. (ed.) (Rutherford High Energy Lab., Chilton (England)). May 1967. 86p. Dep. CFSTI. UK 15s. 0d.

The work of the following divisions of the Rutherford High Energy Laboratory is reported in detail: High Energy Physics, Nimrod, Applied Physics, Proton Linear Accelerator, Engineering, Administration. Lists of publications by the staff are included. Separate abstracts are prepared for the first four sections. (UK)

For abstracts of individual sections see: 33599 and 33810–33812.

33810 (RHEL/R–144, pp 41–59) NIMROD DIVISION. (Rutherford High Energy Lab., Chilton (England)).

The discussion of the Harwell synchrotron includes synchrotron operation and development, and the accelerated beam utilization and transport components. Also targets for high-energy physics experiments are considered. (J.F.P.)

33811 (RHEL/R–144, pp 61–71) APPLIED PHYSICS DIVISION. (Rutherford High Energy Lab., Chilton (England)).

The variable-energy cyclotron, computing activities, track analysis, bubble chambers, superconducting magnets, and radiation protection for various accelerators are discussed. (J.F.P.)

33812 (RHEL/R–144, pp 73–83) PROTON LINEAR ACCELERATOR DIVISION. (Rutherford High Energy Lab., Chilton (England)).

Nuclear physics experiments using the proton linear accelerator are described. These include elastic and inelastic proton scattering by nuclei, and pick-up and charge-exchange reactions. Also the operation and development of the proton linear accelerator are discussed. (J.F.P.)

33813 (AEC-tr–6719, pp 103–4) EXPERIMENTAL CHECK OF PROTECTION CALCULATIONS FOR ELECTRON ACCELERATORS. Korenkov, I. P. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

The results of some theoretical calculations of electron accelerator shielding are reported. The data are compared with experimental radiation monitoring for a 2.5 MeV electron accelerator with 160 μA mean current at a tungsten target of optimal thickness. (B.G.D.)

33814 45-GeV PROTON SYNCHROTRON PROJECT. Parain, J. (CEN, Saclay, France). J. Phys. (Paris), Colloq., 27: C4.49–53 (Nov.–Dec. 1966). (In French).

The study group for the national synchrotron has been commissioned recently to study a 45-GeV proton synchrotron project. This alternating-gradient synchrotron will deliver 10^{12} protons by second. The main parameters and a description of the accelerator are given. (auth)

33815 INDUCED RADIOACTIVITY IN THE COLLIMATOR SYSTEM OF A 31 MeV BROWN BOVERI BETATRON. Stroemme, Aksel (Norwegian Radium Hospital, Oslo). Phys. Med. Biol., 12: 25–8(1967). (NYO–3364–21).

The doses received by the hands of operators who have to handle the removable gamma-ray collimator were measured and found not to exceed 4 mR/day, so long as care is taken not to touch the most radioactive part near to the target. (auth)

33816 THE NRL-ISOCHRONOUS CYCLOTRON MULTI-USER ON-LINE DATA ACQUISITION SYSTEM. Doede, J. (Electro-Mechanical Research, Inc., Minneapolis); Buchler, D.; Allas, R.; Smith, M. IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 614–19(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The operating features of the SOPHYA (Supervisor of Physics Analysis) system as implemented for an EMR Advance Series 6050 computer at the Naval Research Laboratory's Isochronous Cyclotron are explained. Several independent experiments may be run concurrently with additional capability for a batch processing shadow time job. Each experimenter has access to the full library of general routines. The special purpose routines may be coded in Fortran or Assembly Language and included in the library. Standard package includes MATRIX SLICE routines, CRT display routines for single parameter and two parameter contour map or isometric display. Light pen control allows such operations as background subtraction, rotation of axes, etc. A digital method of particle identification is discussed in which an algorithm for evaluation of an identification constant is computed in realtime. (auth)

33817 FARADAY CUP AND SECONDARY-EMISSION MONITOR CALIBRATION. Godlove, T. F.; Toms, M. E.; Jones, D. W.; Murray, K. M. (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 215–16(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

Two small Faraday cups, one shielded and one unshielded, were built and calibrated for efficiency vs electron energy. Measurements with a pulse beam transformer gave the absolute efficiency by means of a unique method: direct measurement of the ratio of the lost current to the incident beam current. Efficiencies for the unshielded cup are in the range 93 to 99 percent with uncertainties of 0.5 percent for electron energies from 10 to 50 MeV. The shielded Faraday cup has a measured efficiency of 97.8 ± 0.2 percent over the electron energy range from 10 to 60 MeV. This cup was used to calibrate the secondary emission produced by electrons or positrons incident on a 0.4 mm Be target. The resulting positive current was 4.3 ± 0.3 percent of the incident beam current over the energy range of 15 to 40 MeV. (auth)

33818 METHOD FOR CONSTRUCTING AND USING NOMOGRAMS IN ORDER TO DETERMINE THE OPERATIONAL EFFICIENCY OF LINEAR ELECTRON ACCELERATORS. Armenskii, E. V.; Pyatnov, E. G.; Chalyi, V. D. Izmer. Tekh., No. 5, 55–7(May 1967). (In Russian).

Even experienced operators of linear accelerators are often unable to determine the optimum supply parameters of accelerators for a given accelerated electron beam. In order to overcome this difficulty, a nomogram was constructed to facilitate optimization of the operation. An equation correlating the electron beam energy, the frequency of the generator, the accelerated particle current and specific constants was solved on a nonlinear analog computer, in order to optimize the supply parameters. On the basis of the results obtained, nomograms applicable to the control of the accelerator were constructed. The best energy control in the 2.2 to 2.6 MeV range was obtained at a constant and lowest value of 1.1 Mw; the frequency of the high-frequency generator followed a parabolic relation. Use of the nomograms facilitates operation of the accelerator without requiring large expenditures. (TTT)

33819 THEORY OF COHERENT TRANSVERSE STABILITY FOR A CHARGED-PARTICLE BUNCH. Derbenev, Ya. S.; Dikanskii, N. S. At. Energ. (USSR), 22: 191–4(Mar. 1967). (In Russian).

The theory deals with the effect of finite wall conductivity on the stability of coherent betatron oscillations of particle bunches in a storage ring, and yields expressions for the decrement of these oscillations. Reference is made to a previous communication (Atomnaya energiya, 21: 176(1965)) in which a similar theory is developed for a bunch of infinitely short lengths. Here the length of the bunch is taken into account, making it necessary to introduce the variation of magnetic field over this length. Effect of the vertical component of beam current is also considered, and shown to be more important for short bunches. (ATD)

33820 INVESTIGATION OF COHERENT PHASE SELF OSCILLATIONS IN STORAGE RINGS. Auslender, V. L.; Karliner, M. M.; Lazarenko, B. A.; Popov, S. G.; Sedlyarov, I. K.; Skrinskii, A. N.; Shekhtman, I. A. At. Energ. (USSR), 22: 194–7(Mar. 1967). (In Russian).

The results of the experimental investigations of the different forms of phase instability in the storage rings VEPP-2 and VEP-1 were reported. The phase self-oscillation of the bunch as a whole and decomposition of the bunch into two oscillating bunches

were investigated. The excitation of the auto-oscillation by interaction of the bunch with resonances at the eighteenth harmonic was observed. Threshold currents and the dependence on the tuning of the fundamental auxiliary resonances were measured. (tr-auth)

33821 STARTUP OF THE 25-MeV, RIGID-FOCUSING LINEAR PROTON ACCELERATOR. Batalin, V. A.; Kapchinskii, I. M.; Kul'man, V. G.; Lazarev, N. V.; Murin, B. P.; Nevyazhskii, I. Kh.; Plotnikov, V. K.; Polyakov, B. I.; Solnyshkov, A. I. At. Energ. (USSR), 22: 239-40(Mar. 1967). (In Russian).

The linear proton accelerator I-2 of the GKAE Institute of Theoretical and Experimental Physics (State Commission of Atomic Energy) is described. This accelerator yields 25-MeV protons in 30 μsec pulses. Beam intensity during pulses was 30 mA at the start, but was later raised to 100 mA and is still being increased. The accelerator was planned as second injector for the 7-BeV ITEF proton synchrotron, and also as model for the design of the projected I-100 linear accelerator, to be used as injector for a future 70-BeV proton synchrotron. Protons are fed into the I-2 accelerator-injector here described by a 710 kV pre-injector which uses a duo-plasmatron as ion source. The I-2 accelerating system is of the resonator type consisting of two cylindrical copper resonators 1.37 m in diameter and 6 and 12 m in length. The total number of drift tubes is 55, and magnetic lenses ensure focussing (F ~ DO focussing in the first resonator and FOFDOD focussing in the second). Accelerating frequency is 148.5 Mc. Power stability is achieved to an accuracy of $\pm 2 \cdot 10^{-7}$ in frequency and ±2° in phase. Specifications are also given in detail regarding adjustment procedures, especially tuning and focussing, and also concerning the vacuum system, which uses oil diffusion pumps. (auth)

33822 STATUS REPORT ON COLLIDING BEAMS ACTIVITY AT THE NUCLEAR PHYSICS INSTITUTE OF THE SIBERIAN BRANCH OF THE ACADEMY OF SCIENCES OF THE USSR. Budker, G. I. (Academy of Sciences, USSR). At. Energ. (USSR), 22: 163-4(Mar. 1967). (In Russian).

Work done on three types of accelerators, the electron-electron storage ring, the electron-positron storage ring, and the accelerator with counter antiproton-proton beams is briefly described. The general design of the accelerator with counter antiproton-proton beams is given. (J.S.R.)

33823 STUDY OF SELF EXCITATION AND RAPID DAMPING OF COHERENT TRANSVERSE OSCILLATIONS IN VEPP-2 STORAGE RING. Auslender, V. L.; Dikanskii, N. S.; Karliner, M. M.; Sedlyarov, I. K.; Skrinskii, A. N.; Shekhtman, I. A. At. Energ. (USSR), 22: 198-200(Mar. 1967). (In Russian).

In the VEPP-2 storage ring the phenomenon of fast damping of coherent vertical betatron oscillation after collision with inflectors and vertical and radial coherent instabilities was observed. The conditions for the development of the instabilities were determined and some methods for their suppression were tested. It was shown that the observed effects can not be explained by losses in the walls. (tr-auth)

33824 LIFETIME AND SIZE OF ELECTRON (OR POSITION) BEAM IN STORAGE RING AT LOW CURRENT VALUES. Auslender, V. L.; Zinin, E. I.; Kulipanov, G. N.; Mishnev, S. I.; Popov, S. G.; Skrinskii, A. N.; Tumaikin, G. M.; Shatunov, Yu. M. At. Energ. (USSR), 22: 200-3(Mar. 1967). (In Russian).

The measurements described were performed on the VEP-1 electron storage ring and the VEPP-2 electron–position storage ring. The lifetime and dimensions of the particle beam were determined at low current values (VEP-1: 2 mA, VEPP-2: 0.1 mA), i.e., when these parameters do not depend appreciably on particle density. The above parameters are plotted against particle energy (VEP-1 up to 150 MeV, VEPP-2 up to 500 MeV) and accelerating-resonator voltage (respectively up to 6000 and 10,000 V). Density distribution in the beam was found to be accurately Gaussian, and in general predictions regarding effects of multiple scattering and quantum fluctuations on beam size agree with experimental results. Because of the high vacuum level (3.10^{-8} mm Hg) direct measurement of the pressure along the orbit was not practical, and instead this pressure was deduced from the bremsstrahlung generated by the beam itself. (ATD)

33825 INFLUENCE OF THE NUMBER OF PARTICLES IN A STORAGE RING ON THE LIFETIME AND DIMENSIONS OF THE BEAM. Auslender, V. L.; Kulipanov, G. N.; Mishnev, S. I.; Popov, S. G.; Skrinskii, A. N.; Tumaikin, G. M. At. Energ. (USSR), 22: 203-6(Mar. 1967). (In Russian).

The lifetime and size of electrons and position beams in VEP-1 and VEPP-2 storage rings were studied at intensity levels (resp. up to 0.5 and 2 a for electrons, up to 20 mA for positions) where particle-interaction effects become important, and in the absence of noticeable instabilities. The above parameters were plotted against beam intensity at various energy values (VEP-1 up to 135 MeV, VEPP-2 up to 150 MeV). Effects contributing to decrease beam lifetime include mutual scattering of beam particles (Ada effect), interaction with charge-compensating ions, and, at high energy levels, wall contamination under the influence of synchrotron radiation. The mutual scattering effect is separated from the others; it increases when beam size decreases, as happens for instance when the ion-removal system is turned on. In general theoretical predictions are confirmed by experimental results. (ATD)

33826 INJECTION AND ACCUMULATION OF POSITRONS. Auslender, V. L.; Vsevolozhskaya, T. A.; Danilov, L. L.; Mishnev, S. I.; Naumov, A. A.; Sil'vestrov, G. I.; Skrinskii, A. N. At. Energ. (USSR), 22: 206-10(Mar. 1967). (In Russian).

The production and injection of positrons into storage rings was described. The positron beam was produced by the conversion of electrons on internal targets and was formed by means of a special short focusing lens. The introduction of the particles into storage rings was accomplished, below average density, with one cycle capture. The analysis of the conditions guaranteeing the maximum capture coefficients was equal to 1×10^{-4} at vertical aperture of the magnet $\Delta_z = \pm 37$ mn and horizontal $\Delta_R = \pm 30$ mn. The methods and results of the adjustment of the system to obtain and inject positrons were described. The optimum conditions for capture and accumulation were studied. (tr-auth)

33827 INJECTION MAGNETS OF POSITRON–ELECTRON STORAGE RING VEPP-2. Vsevolozhskaya, T. A.; Pakin, V. N.; Sil'vestrov, G. I. At. Energ. (USSR), 22: 210-15(Mar. 1967). (In Russian).

The Fe-free magnets by means of which the positron and electron beams are introduced into the storage ring path are described. The magnets have a curved flat coaxial geometry on which the current pulse is presented in a special form with duration of ~100 μsec and amplitude greater than 200 kA with stability not less than 0.1%. The thickness of the external wall separating the area of the working field of the magnet from the storage ring input is 2 mm and the amplitude of the internal field is ~0.1% of the field aperture. The results of the calculation and measurement of the internal field and the experimental data and the effect on the accumulation process are reported. (tr-auth)

33828 BEGINNING OF EXPERIMENTS ON POSITRON–ELECTRON STORAGE RING VEPP-2. Auslender, V. L.; Budker, G. I.; Naumov, A. A.; Pestov, Yu. N.; Sidorov, V. A.; Skrinskii, A. N.; Khabakhpashev, A. G. At. Energ. (USSR), 22: 173-5(Mar. 1967). (In Russian).

The first high energy physics experiment on the positron-electron storage ring VEPP-2 was described. The system uses spark chambers with photographic recording. The measurement of the luminosity was made by positron-electron scattering at small angles. (tr-auth)

33829 MEASUREMENTS OF LUMINOSITY IN COLLIDING BEAMS BY SMALL ANGLE SCATTERING. Auslender, V. L.; Mishnev, S. I.; Onuchin, A. P.; Pakhtusova, E. V.; Popov, S. G.; Sidorov, V. A.; Skrinskii, A. N.; Khabakhpashev, A. G. At. Energ. (USSR), 22: 176-8(Mar. 1967). (In Russian).

The optimum operational regime of the instrument with counter electron-electron and electron-positron beams is easy to select by measurement of small angle scattering. The large cross section of this process makes possible a high calculation speed and a luminosity control operationally. In the system used the electrons and positrons are recorded with scintillation counters, incorporated in a fast-slow coincidence scheme. The counting speed observed does not contradict the results of the measurement of the geometric parameters of the beam. (tr-auth)

33830 NON-LINEAR RESONANCES OF BETATRON OSCILLATIONS IN STORAGE RINGS. Auslender, V. L.; Korobeinikov, L. S.; Kulipanov, G. N.; Mishnev, S. I.; Popov, S. G.; Skrinskii, A. N.; Tumaikin, G. M.; Shatunov, Yu. M. At. Energ. (USSR), 22: 179-88(Mar. 1967). (In Russian).

The results of a study of the effect of nonlinear resonances of high order of betatron oscillations on the lifetime and dimensions of the stored beam at different energies were reported. The effect of resonances on the storage ring was investigated. The mechanism of particle loss was explained. (tr-auth)

33831 INTERACTION OF COHERENT BETATRON OSCILLATIONS WITH EXTERNAL SYSTEMS. Dikanskii, N. S.; Karliner, M. M.; Skrinskii, A. N.; Shapiro, V. E.; Shekhtman, I. A. At. Energ. (USSR), 22: 188-91(Mar. 1967). (In Russian).

The accelerated damping of the betatron oscillations observed in the VEPP-2 storage ring cannot explain the final conductivity of the chamber wall. In connection with this the interaction of bunches with different types of parasite dissipation systems was examined. It was shown that at a given frequency of the betatron oscillation

both accelerated damping and self-excitation of the coherent oscillations were dependent on the resistance of the interacting elements for combination frequency. The decrements and increments found can significantly exceed the magnitudes dependent on the final conductivity of the chamber walls. (tr-auth)

33832 MEASUREMENT OF THE BEAM CURRENT IN THE 6-GeV ELECTRON SYNCHROTRON DESY UTILIZING THE SYNCHROTRON RADIATION. Haensel, R.; Sonntag, B. (Univ., Hamburg). J. Appl. Phys., 38: 3031-2(June 1967).

An optical method for measuring the beam current in the 6-GeV electron synchrotron DESY which is based upon a measurement of the intensity of the synchrotron radiation given off by the electrons is presented. (B.G.D.)

33833 A FAST MECHANICAL BEAM STOP AND OTHER AUXILIARY BEAM CONTROL EQUIPMENT. Jensen, B.; Plendl, H. S.; Nelson, J. W. (Florida State Univ., Tallahassee). Nucl. Instrum. Methods, 53: 153-6(July 1967).

A mechanical beam stop for work with short-lived beta and gamma activities is described. It opens or closes within 50 msec, is simple to build and use, and performs reliably over many successive opening and closing cycles. Also described are a variable-width double-slit system for beam collimation and a beam viewer. (auth)

33834 RADIATION SHIELDING FOR AN MP TANDEM ACCELERATOR INSTALLATION. Overley, J. C.; Holeman, G. R.; Parker, P. D.; Bromley, D. A. (Yale Univ., New Haven). Nucl. Instrum. Methods, 53: 56-60(July 1967).

The efficacy of the radiation shielding for the Yale University Model MP Tandem Van de Graaff Accelerator was studied. The accelerator was used to produce 10 and 25 μA proton beams at 19.2 and 15 MeV respectively which were then allowed to strike a thick, water-cooled aluminum target. Neutron and γ-ray dose rates and neutron energy spectra were measured at various locations throughout the accelerator building; the shielding was found to be satisfactory. (auth)

33835 TARGET PRODUCTION BY DIRECTIONAL EVAPORATION IN HIGH VACUUM. Lishenko, L. G.; Nazarova, T. S.; Khalin, N. F.; Shelenko, V. P. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 12: 515-16(Mar. 1967). (In Russian).

In order to decrease the scattering of metal vapor, a nitrogen trap made of copper tubing and continuously cooled with liquid nitrogen is provided with teflon insulation. It is thus possible to create a potential difference of 1000 volts between the metal evaporator and the condenser right in the working chamber. A potential similar to the evaporator potential can be applied to the liquid nitrogen trap. Thus, the metal vapor is directed to the backing and does not precipitate out on the trap. The liquid nitrogen trap, having the same charge as the metal particles, serves as a screen and prevents deposition of metal on the glass dome of the working chamber. Targets of natural magnesium and ytterbium were prepared by this method of directional evaporation. The design is intended to conserve isotopically enriched materials used in the preparation of targets for nuclear studies. Details of construction of the nitrogen trap are given. (TTT)

33836 AUTOMATIC PROFILE OF BEAMS OF IONIZED PARTICLES. Dufournaud, J. (Institut du Radium, Orsay, France). Rev. Phys. Appl., Suppl. J. Phys., 1: 308-10(Dec. 1966). (In French).

In order to control the spatial distribution of primary or secondary beams from accelerators, an automatic apparatus was designed to assure the spatial distribution of the beam and to control the stability for experiments of long duration. The principle of operation, general description, associated electronic circuits, and the performance of the apparatus are discussed. (J.F.P.)

33837 DESCRIPTION OF A GAS TARGET FOR STUDY OF NUCLEAR REACTIONS. Cremet, J. P.; Lambert, M.; Lefevre, G.; Rais, L. Rev. Phys. Appl., Suppl. J. Phys., 1: 267-72 (Dec. 1966). (In French).

For studying nuclear reactions, a gaseous target assembly using a differential pumping unit is described. The electronic detection equipment is described and typical experimental results are presented. (auth)

33838 "NINA" IS A SMASHER. Stubbs, P. New Sci., 34: 698-9(June 22, 1967).

A brief description is given of the new 4 GeV electron synchrotron at Daresbury, England (Science Research Council), including programmes of studies. (UK)

33839 NUCLEAR RESEARCH DEVELOPMENTS AT CERN, NO. I: INTERSECTING STORAGE RINGS AND PROTON SYNCHROTRON. Engineer, 223: 880-1(June 9, 1967).

Current developments in equipment for the production of nuclear particles at CERN are outlined. The design of the intersecting storage rings and of the 28 GeV proton synchrotron are briefly described, and the main parameters are given. Progress in the construction of the storage rings and in the programme of improvements to the synchrotron is reported. (UK)

33840 MIGHTY MACHINES TO MEASURE THE MINISCULE. Engineering, 203: 932-2(June 9, 1967).

A brief survey is presented of the facilities and research at CERN. Particular mention is made of neutrino research, the accelerator storage rings, and ISOLDE, the on-line isotope separator. (UK)

33841 CERN AND THE BIG MACHINE. Amaldi, Eduardo. Nature, 214: 1290-2(June 24, 1967).

The project for building a 300 GeV proton synchrotron was one of the principal items on the agenda of the Council of CERN which met at Geneva on June 14–15. There were discussions of the extension of the CERN convention to include a second laboratory, and of the procedure to be used in selecting one of the nine sites on offer. The council also discussed the place of the 300 GeV proposal in the future development of high-energy physics in Europe. (auth)

33842 4 GeV ELECTRON SYNCHROTRON AT DARESBURY, No. I: MAGNET AND POWER SUPPLY. Engineer, 223: 922-3 (June 23, 1967).

In the strong focusing electron synchrotron known as NINA, electrons from a 40 MeV linear accelerator are injected into the toroidal vacuum chamber where they are accelerated by 5 rf stations and are kept in a circular orbit of 230 ft diameter by 40 magnets. The magnets, vacuum chamber, and magnet power supply are described. (UK)

33843 PARTICLE ACCELERATORS. Kollath, R. (ed.). Londcn, Pittman and Sons Ltd., 1967. 337p. 75s.

Translated from German text Teilchenbeschleuniger (2nd. Ed.)., 1962, by W. Summer.

The principles of particle accelerators, together with a description of their construction and function, are dealt with under the following chapter headings: Elementary review and classification of subject matter–The betatron–The electron synchrotron (phase focusing)–The microtron–The classical cyclotron–The synchrocyclotron–Proton synchrotron with weak focusing–Theoretical treatment of accelerators with azimuthally variable magnetic fields (AVF)–The isochroncyclotron–The 500 MeV Bonn AG electron synchrotron–The AG proton synchrotron–Linear accelerators–Outlook for further development–Applications of particle accelerators. About 300 references. An appendix outlines the most important developments since 1962. (UK)

33844 PHASE SPACE DENSITY STUDIES ON CYCLOTRON ION SOURCES. Mallory, Merrit Lee. East Lansing, Mich., Michigan State Univ., 1966. 88p.

Thesis.

A facility has been set up for development and testing of cyclotron ion sources with special emphasis on capability for rapid phase space density measurements. H^+ ions from the test source are accelerated into a –30 kV dc dee and magnetically deflected through 180°. A system of remotely adjustable slits is mounted inside the dee and is used to determine the axial and radial emittance areas. The phase space density was determined from the axial and radial emittance area measurements at a variety of arc conditions and for a number of source geometries. All studies employed a 0.062″ × 0.375″ source output slit with arc currents varied from 1 to 5 A. Geometrical variations were principally concerned with source face shapes. Both axial and radial emittance areas from a normal flat source are found to have a considerable admixture of coherent motion which results in inefficient use of the aperture and also, in combination with nonlinear fields, can lead to an effective dilution of the phase space density. Moderate recessing of the source contributes a focusing force in both r and z and makes the phase space volume much more compact. The effects of plasma boundary and space charge are evidenced in the axial measurements. The axial plasma boundary is found to be concave, with the result that ions emitted from the top and bottom of the ion source slit focus toward the median plane. Space charge effects are clearly discernible; the axial width of the beam linearly increases as a function of total beam current. In the radial emittance area measurements, an asymmetry in the radial position of maximum current was found and traced to a shifting plasma boundary. This shift was subsequently shown to be the result of a strain displacement of the ion source filament. (Disser. Abstr.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 32540, 33884, 33958, 33969, 34057, and 34078.

33845 (AAEC/E-174) DIFF: A CODE TO PREPARE NEUTRON DIFFUSION THEORY PARAMETERS FROM THE RESULTS OF THE CODE WDSN. Spinks, N.; Manning, G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar. 1967. 23p. Dep.

With a solution of the multigroup neutron transport equation available for a problem in one dimensional geometry, diffusion theory parameters are determined so as to reproduce in diffusion theory the essential characteristics of the transport solution. Calculation of a more realistic reactor configuration can then be attempted in diffusion theory. Diffusion coefficients, taken as constant within a uniform region, can be determined so that the diffusion flux is an optimum fit to the transport flux. As an option the conventional $\frac{1}{3}\,\Sigma_{t_r}$ can be used. The homogeneous boundary condition is found from a diffusion theory calculation which uses the transport net current as an inhomogeneous boundary condition. The homogeneous boundary condition forces the diffusion theory to reproduce exactly the transport leakage and multiplication constant. A discontinuity in the diffusion flux is permitted at interfaces between different materials. Interface conditions, if applied, guarantee that any reaction rate, integrated over the volume of a uniform region, is preserved by the diffusion theory. The DIFF code uses the results of the WDSN transport code to calculate diffusion theory parameters for the CRAM diffusion code. (auth)

33846 (AAEC/TM-370) CONVERSION OF THE NEUTRON CODE TDC TO FORTRAN IV. McGregor, B. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb. 1967. 9p. Dep.

The conversion of the code TDC from CDC 1604 FORTRAN to FORTRAN IV is discussed with some notes on additional options provided. A series of test problems was devised and run and some points on code usage are reported. (auth)

33847 (AE-279) CALCULATIONS OF NEUTRON FLUX DISTRIBUTIONS BY MEANS OF INTEGRAL TRANSPORT METHODS. Carlvik, I. (Aktiebolaget Atomenergi, Stockholm (Sweden)). May 1967. 95p. Dep. SWED.

Flux distributions were calculated, mainly in one energy group, for a number of systems representing geometries interesting for reactor calculations. Integral transport methods of two kinds were utilized; collision probabilities (CP) and the discrete method (DIT). The geometries considered comprise the three one-dimensional geometries, plane, spherical, and annular, and further a square cell with a circular fuel rod and a rod cluster cell with a circular outer boundary. For the annular cells both methods (CP and DIT) were used, and the results were compared. The purpose of the work is twofold: to demonstrate the versatility and efficacy of integral transport methods and to serve as a guide for anybody who wants to use the methods. (auth)

33848 (AE-281) COLLISION PROBABILITIES FOR FINITE CYLINDERS AND CUBOIDS. Carlvik, I. (Aktiebolaget Atomenergi, Stockholm (Sweden)). May 1967. 29p. Dep.

Analytical formulas were derived for the collision probabilities of homogeneous finite cylinders and cuboids. The formula for the finite cylinder contains double integrals, and the formula for the cuboid contains only single integrals. Collision probabilities were calculated by means of the formulas and were compared with values obtained by other authors. It was found that the calculations using the analytical formulas are much quicker and give higher accuracy than Monte Carlo calculations. (auth)

33849 (BNWL-436) COMPILATION OF DOUBLY DIFFERENTIAL CROSS SECTIONS AND THE SCATTERING LAW FOR H_2O AND D_2O AT 299°K AND FOR H_2O AT 268°K. Harling, O. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1967. Contract AT(45-1)-1830. 125p. Dep. CFSTI.

A compilation of slow neutron inelastic scattering cross sections is presented for H_2O at 268 and 299°K and for D_2O at 299°K. The doubly differential cross sections and, from these, the Egelstaff scattering law were obtained from measurements made with the Battelle rotating-crystal time-of-flight spectrometer. Maximum energy transfers by downscattering at 0.6, 0.21, and 0.6 eV with wave vector $\bar{k} = \bar{P}/\hbar$ transfers up to 32, 9.5, and 32 Å were used, respectively, with H_2O, D_2O, and light ice. (D.C.W.)

33850 (CONF-670707-2) MODEL FOR THERMALIZATION. Daitch, P. B.; Jenkins, J. D. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science). [1967]. Contract AT(30-3)-328. 14p. Dep. CFSTI.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich.

An intuitive model for thermalization, in which leakage is described by a DB^2 term, is outlined. The parameters of the model are adjusted to fulfill boundary conditions using a variational approach. Since the model uses actual total, transport, and energy-exchange cross sections, various integrals have to be evaluated using numerical quadrature. Comparison of results obtained using this model with exact calculations using multigroup diffusion theory indicates that this model is applicable over a wide range of buckling, energy, and time. (D.C.W.)

33851 (CTH-RF-11) EVALUATION OF DECAY CONSTANTS WITH AN INTEGRATION AND A MOMENT METHOD. Collen, Jan; Elkert, Jan; Grosshog, Gudmar (Chalmers Tekniska Hogskola, Goteborg (Sweden). Institutionen for Reaktorfysik). May 1967. 21p. Dep. SWED.

For the evaluation of decay constants in pulsed neutron source experiments, two methods were studied. Both of them are extensions of Peierls method, and they can be used in the presence of higher harmonic modes. In the first method the channel contents are integrated repearive over the time. If this process is carried far enough, decay constants for the various modes are obtained. The second method is based on a calculation of the time moments. It is shown that this method gives more reliable values, mainly because the statistical errors do not build up so rapidly as in the first method. Therefore, the moment method has been investigated in detail, and a computer code has been developed for its use. (auth)

33852 (EANDC-58(U)) THIRD BIENNIAL REPORT OF THE ACTIVITIES OF THE EUROPEAN AMERICAN NUCLEAR DATA COMMITTEE. Bretcher, E.; Batchelor, R. (European-American Nuclear Data Committee). May 1966. 10p. Dep.

The activities of the European-American Nuclear Data Committee between January, 1964, and January, 1966, are summarized. (D.C.W.)

33853 (EANDC(E)-78(U)) INTRODUCTION TO KFK 120 "NEUTRON CROSS SECTIONS FOR FAST REACTOR MATERIALS." PART I. "EVALUATION." Schmidt, J. J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Mar. 1967. 12p. Dep.

The neutron data evaluation that has been performed at Karlsruhe since the beginning of the fast breeder reactor project in 1960 is outlined. (D.C.W.)

33854 (GA-7169) GAF: A COMPUTER PROGRAM FOR CALCULATION OF NEUTRON SPECTRA AND AVERAGE CROSS SECTIONS IN THE HIGH ENERGY REGION. Mathews, D. R.; Archibald, R. J. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Jan. 20, 1967. Contract AT(04-3)-167. 75p. Dep. CFSTI.

A computer program, GAF, was written to compute neutron fluxes and currents from the B_1 equations for a maximum of 1740 energy groups above the thermal energy region. The calculated fluxes may be used to prepare average cross sections for up to 99 broad energy groups. Special data handling techniques are used to allow the practical utilization of such a large number of energy groups. The program is written in the FORTRAN-IV language for the UNIVAC-1108 computer. (auth)

33855 (JINR-P2-3315) RESHENIE KINETICHESKOGO URAVNENIYA DLYA NEITRONOV VYSOKIKH ENERGII S UCHETOM UGLOVYKH OTKLONENII. PRIBLIZHENIE KVAZIUPRUGOGO RASSEYANIYA. (Solution of a Kinetic Equation for High Energy Neutrons Taking into Account the Angular Deviation. Quasi-Elastic Scattering Approximation). Komochkov, M. M.; Sychev, B. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 21p. (In Russian). Dep.

A kinetic equation is solved under the assumption that the flux density gradient is determined on the whole by a part of a cascade neutron spectrum which is described by a quasi-elastic scattering model. The angular deviations are taken into account by means of establishing the mean cosine of the neutron motion direction and its energy. An analytical expression for the neutron energy spectrum in the shielding is obtained. (auth)

33856 (KAPL-P-3338) EPITHERMAL NEUTRON INELASTIC SCATTERING AND SCATTERING LAW FOR H_2O. Kirouac, G. J.; Moore, W. E.; Esch, L. J. (Knolls Atomic Power Lab., Schenectady); Yeater, M. L. (Rensselaer Polytechnic Inst., Troy, N. Y.).

[1967]. Contract W-31-109-eng-52. 21p. (CONF-670707-3). Dep. CFSTI.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich.

A new double-differential scattering system at the Rensselaer Linear Accelerator Laboratory has been used to study the interactions of neutrons with liquid H_2O through energy-loss scattering. Measurements were recently made at six scattering angles and several incident neutron energies in the range 0.15 to 0.63 eV. Room temperature data were reduced to the cross section $\delta^2\sigma/\delta\Omega\delta E$, and the scattering law $S(\alpha,\beta)$. All of the results have been corrected for multiple scattering. The generalized frequency distribution $p(\beta)$ was also derived from the scattering law. Comparison of these measurements with calculations based on several different theoretical molecular models provides a sensitive test of the scattering kernels used for reactor thermalization problems. A model based upon the Haywood frequency distribution and the McMurry-Russell model were in fairly good agreement with the experimental results for most of the energy and angular range. Although substantial disagreements remain, particularly for the low energy transfers, either model will probably be sufficiently accurate for most reactor calculations. (auth)

33857 (KFKI-11/1967) SLOW NEUTRON SCATTERING BY SOLID METHANE. Solt, G. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1967. 10p. Dep.

To explain the discrepancy between the observed neutron scattering data and some theoretical results obtained for solid methane, the effects of rotational hindrance are considered. It is shown, that although hindrance can lead to a slight enhancement of inelastic scattering, the observed high ratio of inelastic to elastic intensity for solid methane near the melting point can be understood only by assuming a characteristical frequency for molecular translation not higher than 50 cm^{-1}. (auth)

33858 (MIT-2344-07) USE OF A PULSED NEUTRON SOURCE TO DETERMINE NUCLEAR PARAMETERS OF LATTICES OF PARTIALLY ENRICHED URANIUM RODS IN HEAVY WATER. Bliss, H. E.; Kaplan, I.; Thompson, T. J. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Sept. 1966. Contract AT(30-1)-2344. 210p. (MITNE-73). Dep. CFSTI.

The pulsed-neutron technique was used to determine the nuclear parameters of a number of subcritical lattices of slightly enriched uranium metal rods in heavy water. Experimental values of the fundamental mode decay constant λ and geometric buckling B^2 were related to the multiplication factor k_∞ and the absorption cross section $\overline{\nu\Sigma_a}$ by a two-group model. The thermal diffusion area ($L^2 \equiv \overline{\nu D_0}/\overline{\nu\Sigma_a}$) was also obtained with calculated values of $\overline{\nu D_0}$. The values of k_∞ are generally in agreement, within experimental uncertainties, with values obtained with the method of added absorbers, with the four-factor formula, and with the two-group critical equation. The values of $\overline{\nu\Sigma_a}$ and L^2 are in agreement with the values computed with the THERMOS code. The overall uncertainties in the values of k_∞ vary from 1.5 to 4.5% with the larger values attributed to statistical fluctuations in the experimental data. Known systematic sources of error presently limit the accuracy of the pulsed neutron method to between 1.0 and 1.5%. Measurements were made in two-region assemblies; the values of k_∞ obtained in the test region agree, within experimental uncertainties, with those obtained with the four-factor formula in lattices composed entirely of the test region medium. Values of k_∞ and $\overline{\nu\Sigma_a}$ in lattices successively modified by the addition of a distributed neutron absorber were obtained which are more accurate than those determined from pulsed neutron measurements on the unmodified lattices alone. A value of 0.44 ± 0.05 was determined for the return coefficient of thermal neutrons from the graphite-lined cavity below the M. I. T. Lattice Facility experimental tank. (auth)

33859 (NASA-CR-72231) NEUTRON FLUX DISTRIBUTIONS: (EXPERIMENT VS. THEORY) FOR A WATER REFLECTED SPHERICAL CAVITY SYSTEM. Miraldi, Floro; Nelson, George W.; Holmberg, Gary; Skoff, Gerald (Case Inst. of Tech., Cleveland, Ohio). Dec. 31, 1966. Contract NAS 3-6214. 105p.

Neutron flux distributions were measured in a system consisting of a large spherical cavity in water. Mathematical models were designed for the experiments, and theoretical neutron flux distributions were calculated. Three cavity geometries were studied including concentric sphere systems. Cavity fillings were air and BF_3 at various pressures between 0.05 and four atmospheres. Measurements were made by indium foil activation. Foil activation distributions are presented, and relative thermal flux distributions are compared to calculated fluxes. Comparison of theory and experiment shows good agreement. (auth)

33860 (AEC-tr-6719, pp 29-43) DIFFUSION OF NEUTRONS IN A POLARIZING MEDIUM. Kazachenkov, Yu. N.; Orlov, V. V. Translated from Vop. Dozimetry Zashch. Izluch., Moskov. Inzh. Fiz. Inst., Sb. Statei, No. 4, 1965.

Kinetic equations are developed for the diffusion of neutrons in a polarizing medium. The maximum possible change in the diffusion coefficient resulting from polarization is calculated. (S.F.L.)

33861 SUPER-HIGH FLUX NEUTRON SOURCES. Beckurts, K. H. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech., 12: 236-44(May 1967). (In German).

Details are given of existing or projected examples of various kinds of neutron sources: high flux reactors (the Savannah River High Flux Demonstration, the HFIR, the AARR, the SM-2 and the Grenoble Reactor); pulsed reactors (the IBR, the SORA and the APR); and accelerators (the ING). All systems have their own special characteristics, advantages and disadvantages which are also discussed in detail from financial and commercial points of view. The long term prospects for the various systems may be summarized as follows. Today only the high flux reactors have attained sufficient technical maturity. Their development is however already approaching the practical limits and greater efforts to attain higher neutron fluxes will at best perhaps only be undertaken for the special projects involving the production of transuranium elements. Pulsed reactors are only at the beginning of their development. Only when the SORA project becomes a reality will there be an installation in existence whose results are comparable with a high flux reactor. It is true that very advanced pulse reactors could far exceed the performance of high flux reactors in limited areas. A neutron source consisting of a high energy accelerator of the type of the Intense Neutron Generator (ING) could surpass both reactor varieties in respect of output. However because of the high cost there will always be few installations of this kind; indeed it is at the moment doubtful whether or not one will be built. Still other possibilities are of interest in the long term, e.g., nuclear explosions, which have already attained considerable interest in the USA for neutron time of flight spectroscopy, or the use of large quantities of spontaneously fissioning transuranium elements. Thermonuclear fusion also opens up further basic possibilities. The development of high flux neutron sources on the other hand provides nuclear technology with an attractive spur, e.g., for the building of power reactors with very high power densities. (S.F.L.)

33862 GENERATING FUNCTIONS AND REFLECTION AND TRANSMISSION FUNCTIONS. Abu-Shumays, I. K. (Harvard Univ., Cambridge, Mass. Argonne National Lab., Ill.). J. Math. Anal. Appl., 18: 453-71(June 1967).

The techniques of generating functions are applied to the stochastic theory of neutron transport and radiative transfer by using the number n of collisions or "generations" in the chain history of a given initial particle as the exponent for the generating functions. (In previous applications of generating functions to transport theory, the number of neutrons has usually been taken as the exponent.) The treatment is confined to the one energy (velocity) model of neutron or photon transport in slab geometry with homogeneity, axial symmetry, and constant cross sections describing the probabilities of collisions per unit path length. (S.F.L.)

33863 THERMOSTAT FOR NEUTRON CROSS-SECTION MEASUREMENTS WITHIN THE RANGE FROM −196 TO 200°C. Sudnik-Hrynkiewicz, Marek; Olejarczyk, Wiktor; Zieleniewski, Roman; Szkatula, Antoni; Janik, Jerzy A.; Bajorek, Antoni (Inst. of Nuclear Physics, Krakow). Nukleonika, 12: 385-90(1967).

A thermostat for measuring neutron cross sections of thin samples with developed surfaces (up to 400 cm^3) at temperatures within the range from −196 to 200°C is described. The constructional details and the principle of temperature stabilization are given and the method of control described. Remarks on the preliminary use of the thermostat with the pulsed reactor IBR at the Joint Institute for Nuclear Research at Dubna (USSR) are made. (auth)

33864 INVESTIGATION OF INTERFERENCE AND RESONANCE ASYMMETRY EFFECTS IN THE THEORY OF NEUTRON ABSORPTION IN REACTORS. Cook, J. L.; Kletzmayr, E. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Austral. J. Phys., 20: 253-63(June 1967).

The nuclear effects that lead to asymmetric behavior of neutron resonance cross sections are investigated, and general expressions for cross sections are developed. These are shown to be of a form suitable for calculation of escape probabilities, and the functions that arise from them are tabulated. (auth)

33865 CONVERGENCE PROBLEMS ASSOCIATED WITH THE JACOBI POLYNOMIAL METHOD FOR SOLVING BOLTZMANN'S TRANSPORT EQUATION. Nonnenmacher, Th. F.

(Technische Hochschule, Karlsruhe, Ger.). Nukleonik, 10: 27-33(June 1967).

The Jacobi polynomial method was used to calculate some neutron transport properties more accurately than can be obtained by using the well-known spherical harmonics method in the same order of approximation. From the mathematical point of view an important question is whether the Jacobi polynomial expansion of the neutron angular flux converges or not. It is shown that a proof of convergence is only possible by using the concept of generalized functions. Then it is shown that the system of partial solutions generated by the Jacobi polynomial method converges in the distributional sense to the complete set of eigenfunctions given by Case. The question of conservation of the continuity equation is discussed in some detail. (auth)

33866 TABLES RELATED TO THE MEAN SQUARE CHORD LENGTH IN RIGHT PARALLELEPIPEDS. Kristiansen, Gundorph Kjeldgaard; Tollander, Bengt; Tiren, Lars Ingmar (Aktiebolaget Atomenergi, Studsvik, Sweden). Nukleonik, 10: 45-7(June 1967).

Values of $Q = \langle l^2 \rangle / \langle l \rangle^2$, where l is the chord length of a neutron passing through a cavity, have been determined for parallelepipedic boxes. Tables for a range of ratios between the side lengths are given in the report, including results for infinitely long tubes. The results are of use in the calculation of neutron streaming through cavities of the shapes considered. (auth)

33867 CONTRIBUTION OF HEAVIER NUCLEUS ON NEUTRON SLOWING DOWN IN HYDROGENOUS MIXTURE. II. Tanaka, Ryokichi; Mori, Koichi (Kawasaki Dockyard Co. Ltd., Kobe, Japan). J. Nucl. Sci. Technol. (Tokyo), 4: 213-22 (May 1967).

The consistent method of solving the coupled slowing-down equations developed in a previous paper is extended to a study of the second spacial moment of neutron slowing down in a hydrogenous mixture. The duonucleic system constituted by a mixture of hydrogen and nonhydrogen nuclei is treated analytically by application of the Goertzel–Greuling–Amster and Fermi approximations to the latter nucleus. Applying the G.G.A. approximation, an interference effect of scattering due to the respective nuclei appeared in the quantities concerning the first and the last flight of neutrons, and it is shown that, when the mass of the nonhydrogen nucleus becomes infinitely large, the general expression coincides with the result obtained by Volkin. Numerical calculations were performed to compare the different methods proposed in the past. (auth)

33868 ITERATIVE METHOD OF MULTI-POLE SOURCE-SINK CALCULATION FOR FINITE MODERATOR. Kawashima, Kanau (Fuji Electric Co. Ltd., Kawasaki-shi, Japan). J. Nucl. Sci. Technol. (Tokyo), 4: 261-3(May 1967).

An iterative method, using two-group theory, of multipole source–sink calculations is developed to deal with the problem of neutron diffusion in finite moderating systems. A computer code, SATELLITE-5, based on this calculational method was programmed for CDC-3600. Results of a sample calculation are given. (S.F.L.)

33869 DECAY OF A NEUTRON PULSE IN LOW TEMPERATURE BERYLLIUM. Wood, J. (London Univ.). Nukleonik, 10: 3-6(June 1967).

The long-time behavior of a neutron pulse in pure beryllium at temperatures of 21, 0, and –100°C is investigated by solving numerically the homogeneous Boltzmann equation in the diffusion approximation. The discrete eigenvalues found as a consequence of the numerical approach are interpreted as approximating the continuous spectrum of eigenvalues, thus enabling the study of systems for which $B^2 > B^2_{max}$. The effect of increasing buckling and lowering the temperature on the existence of an asymptotic decay constant is shown; values are obtained for the "waiting time" required to achieve an asymptotic energy distribution and the magnitude of the persistent change in the "decay constant" when $B^2 > B^2_{max}$. The applicability of the "Bragg trapping" and $[\nu\Sigma]_{min}$ theories to the results is discussed. (auth)

33870 STATIONARY TRANSPORT OF MONOENERGETIC NEUTRONS IN INHOMOGENEOUS MEDIA. Stepanov, A. V. At. Energ. (USSR), 22: 271-6(Apr. 1967). (In Russian).

The passage of monoenergetic neutrons from stationary forces in nonhomogeneous media which can be described by means of the Boltzmann equation with fluctuating coefficients was examined. The equation for the current of neutrons neutralized by fluctuations in the media was derived. A solution was obtained for this equation in the limiting case where the characteristic dimensions of the inhomogeneity is $1 \gg \lambda_{s0}$ (three path lengths with respect to scattering in the homogeneous media) and $1 \ll \lambda_{s0}$. In the general case $1 \gg L_0$ (neutron diffusion length in homogeneous media). As a measurement of the inhomogeneous media, the periodic lattice of the reactor was examined. (tr-auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 33808, 33812, 34034, 34050, 34054, and 34061.

33871 (CEA-Bib-82) LES ISOTOPES DE L'HYDROGENE: REACTIONS NUCLEAIRES. (Hydrogen Isotopes: Nuclear Reactions). Moulet, Elisee; Gondal, Denise (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1967. 170p. (In French and English). Dep.

References (1720) to literature dealing with deuteron, proton, and triton reactions with light nuclei and certain medium and heavy nuclei are presented. A variety of indexes are included among which the most notable are author, report, and subject indexes. (D.C.W.)

33872 (ORNL–4122) ELECTRONUCLEAR DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1966. (Oak Ridge National Lab., Tenn.). May 1967. Contract W-7405-eng-26. 136p. Dep. CFSTI.

Progress was made on many experiments, notably on proton-proton bremsstrahlung, on proton-proton interactions at very low energies, on shell-model structure studies through pickup of nucleons and through charge exchange, and on characterization of the optical model by the interaction of protons with complex nuclei. Work at high resolution was accomplished using the Elbek spectrometer. Theoretical work continued in close association. In the field of accelerator development, the experimental prototype 4-MeV Separated-Orbit Cyclotron was advanced in design, and earlier prototypes for the 50-MeV SOC were completed and tested. A new polarized source for the ORIC is under construction. (auth)

33873 (NP-tr-1543, pp 1-50) INTERACTIONS OF PROTONS WITH TRITIUM AT ENERGIES BELOW THE (p,n) THRESHOLD. Kurepin, A. B. Translation of a Thesis.

Direct evidence is obtained for the existence of a resonance proton–tritium interaction at low energies by measurement and analysis of elastic scattering of protons by tritium below the (p,n) threshold. Elastic angular distributions were measured for proton energies between 300 and 990 keV over a broad angular range (40 to 152° in the center-of-mass system). A phase analysis of the experimental results was performed with the aid of a computer. (S.F.L.)

33874 RELATIONS BETWEEN SPIN-CORRELATION MEASUREMENTS IN NUCLEON–DEUTERON ELASTIC SCATTERING IF THE CHANNEL SPIN IS CONSERVED. Arvieux, Jacques (Service de Physique Nucleaire a Moyenne Energie, Saclay, France. Institut des Sciences Nucleaires, Grenoble, France); Raynal, Jacques. Nucl. Phys., A100: 473-80(1967).

The nucleon–deuteron elastic scattering cross section with polarized beam and a polarized target is described by 18 quantities (unpolarized cross section, one parameter for the nucleon polarization, four parameters for the deuteron polarization, and 12 spin–correlation coefficients). The channel-spin conservation hypothesis gives eight relations between these 18 quantities. The experimental verification of these relations would check the validity of the hypothesis. (auth)

33875 SCATTERING OF ELECTROMAGNETIC WAVES ON NEUTRAL FERMI PARTICLES. Ternov, I. M.; Bagrov, V. G.; Bordovitsyn, V. A.; Markin, Yu. A. (Moscow State Univ. Tomsk Polytechnic Inst.). Zh. Eksp. Teor. Fiz., 52: 1584-91(June 1967). (In Russian).

Scattering (Compton effect) of plane electromagnetic waves on uncharged fermions with an anomalous magnetic moment is studied. The scattering cross section, probability, and intensity of polarized scattered radiation are found. Spin effects are considered, and it is shown that, as a result of scattering, the particle spin may acquire a predominant orientation. Effects depending on the wave intensity and resulting in emission of secondary harmonics are considered. (auth)

33876 NEW DETERMINATION OF THE DEUTERON BINDING ENERGY. Taylor, H. W.; Neff, N.; King, J. D. (Univ. of Toronto). Phys. Lett., 24B: 659-60(June 26, 1967).

The energy of the thermal-neutron-capture γ ray of hydrogen was measured with a Ge(Li) detector. The observed value is 2223.351 ± 0.046 keV; the corresponding value for the deuteron binding energy is 2224.668 ± 0.046 keV. (auth)

33877 EXPERIMENTAL INVESTIGATION OF THE FINAL-STATE INTERACTION IN THE REACTION H(d,2p)n AT 50 MeV. Brueckmann, H.; Kluge, W.; Schaenzler, L. (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Phys. Lett., 24B: 649-51(June 26, 1967).

The three-particle reaction d + p → p + p + n was studied at a deuteron energy of 51.5 MeV. The measured correlation spectrum exhibits a pronounced effect due to the n–p final-state interaction, and the analysis of the data shows that this interaction is dominated by the virtual singlet state of the deuteron. (auth)

33878 ELECTRIC AND MAGNETIC CONTRIBUTIONS TO ELASTIC ELECTRON–DEUTERON SCATTERING AT HIGH ENERGIES. Buchanan, Charles Donald. Stanford, Calif., Stanford Univ., 1966. 213p.

Thesis.

The electric and magnetic contributions to elastic electron-deuteron scattering were experimentally measured detecting both the scattered electron and the recoiling deuteron and demanding a coincidence between them. Measurements were made at laboratory angles of the scattered electrons of 90 to 145° and at values of q_0^2 (the square of the four-momentum-transfer) from $6.0F^{-2}$ to $14.0F^{-2}$, where $1.0F^{-2} = 197.32$ MeV/c. A measurement was also made at $20F^{-2}$ and 90°. The electric and magnetic contributions to the scattering were separated using the small and large angle data. The electric scattering contribution agrees well with the predictions of the simple impulse approximation theory using reasonable hard-core models of the deuteron wave functions and assuming $G_{EN} = 0$. The magnetic scattering contribution is significantly (≈70%) larger than predicted. This probably indicates either substantial meson-exchange or relativistic effects and may be relevant to the D-state probability of the deuteron. (Disser. Abstr.)

33879 DIFFERENTIAL CROSS SECTIONS FOR THE REACTION $^3He(\gamma,p)^2H$ FROM 45 TO 150 MeV. O'Fallon, Nancy Marie McCumber. Urbana, Ill., Univ. of Illinois, 1966. 78p.

Thesis.

Differential cross sections for the reaction $^3He(\gamma,p)^2H$ were measured for photons of 45 to 150 MeV at five angular settings: (θ_p,θ_d) = (30°, 142°), (60°, 106°), (90°, 75°), (120°. 47.5°), and (135°, 34.5°) in the laboratory. At θ_p of 60° and 90°, $(d\sigma/d\Omega)$ was obtained for photon energies down to 40 MeV. A gaseous ^3He target at about 4°K and slightly less than one atmosphere pressure was bombarded with 250-MeV bremsstrahlung. The deuteron detection system, which was a telescope of three semi-conductor detectors followed by a plastic scintillator, actually defined the solid angle. The proton telescope of four plastic scintillators was large enough to intercept all protons correlated with deuterons in the deuteron telescope. Photographs were made of the pulses from the detectors as displayed on an oscilloscope whenever there was a coincidence between a proton in the proton telescope and a deuteron in the deuteron telescope. Pulse heights were used for particle identification and energy assignment. The θ_p = 90° cross sections ranged from 12.68 ± 0.45 to 1.07 ± 0.14 μb/sr as photon energy increased. These 90° cross sections join quite smoothly with results of previous experiments. The total cross section as a function of photon energy, obtained by integrating the differential cross sections, decreased from 146 ± 5 to 14 ± 2 μb as photon energy increased from 45 to 150 MeV. Integrated and bremsstrahlung-weighted cross sections obtained from the data of this experiment combined with data of lower energy experiments and of three-body photodisintegration experiments are 58.9 ± 4.0 MeV and 2.46 ± .14 mb, respectively. Both values are in reasonable agreement with sum rule calculations, and the integrated cross section is in excellent agreement with a model-independent dispersion-theoretic calculation which includes effects of all multipoles of electric interaction. It was not possible to fit the total cross section with the expression derived for electric dipole transitions with the Gunn and Irving wave function for the ground state of ^3He for any reasonable value of the size parameter. With the size parameter that fits the low-energy data, the calculated high-energy cross sections are roughly a factor of two down from the measured cross sections. (Disser. Abstr.)

33880 ELASTIC AND INELASTIC ELECTRON SCATTERING FROM ^3He. Collard, Harold Rieth. Stanford, Calif., Stanford Univ., 1966. 224p.

Thesis.

The ^3He nucleus was investigated by means of the electron scattering technique. Elastic and inelastic scattered electron spectra were observed for various incident electron energies and electron scattering angles. Absolute cross sections were determined in each case by multiplying the experimentally measured ratio of the ^3He cross section to the cross section for elastic scattering of electrons from ordinary hydrogen by the known absolute proton cross section. High-pressure target cells for both ^3He gas and hydrogen gas were used throughout the investigation. In the case of the elastic scattering investigation, absolute differential cross sections were measured at angles lying between 40 and 135° in the energy range 110 to 663 MeV. Since the ^3He nucleus has a spin equal to ½ ħ, the cross section for the elastic scattering of electrons from ^3He can be described by the Rosenbluth formula. From a number of cross sections measured at different energies and angles, but at the same value of q^2, the square of the four-momentum transfer to the nucleus by the incident electron, it is possible to obtain the charge and magnetic moment form factors for the ^3He nucleus. These form factors were obtained from the measured cross sections in the q^2 range $1-5\ F^{-2}$. The results indicate that the charge cloud of the ^3He nucleus is larger than the magnetic moment cloud. Model-independent determinations of the rms radii of the charge and magnetic moment distributions are 1.87 ± 0.05 Fermis and 1.69 ± 0.10 Fermis respectively. The observation that the charge cloud of ^3He is larger than its magnetic moment cloud was given a simple intuitive explanation in terms of the spatial distributions of the nucleons. The charge is carried by the two protons in ^3He, and since their spins are mainly opposed, the magnetic moment is carried by the neutron. Thus, if the distribution of the pair of protons is more extended in space than that of the single neutron, as one might expect, a natural explanation of the observation follows. The inelastic scattering data were in the form of eight absolute cross sections for the quasi-elastic scattering of electrons from the ^3He nucleus. The measurements were made at angles lying between 45 and 135° in the energy range 360 to 838 MeV. The values of all eight quasi-elastic cross sections agreed within the experimental errors with the sum of the cross sections for two free protons and a neutron. The quasi-elastic spectra were broadly peaked with full width at half-maxima ranging from 50 to 75 MeV. The theoretical predictions of Haybron and of Oakes and Griffy were compared with the experimentally determined spectra, and were found to fit the data poorly in each case. No excited levels or final state interactions of the ^3He nucleus were observed. The elastic and inelastic scattering results are not precise enough to provide specific information about the nuclear force. (Disser. Abstr.)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 32935, 33808, 33812, 33871, 33872, 33907, 33932, 33963, 33964, 33966, 34031, 34032, 34035, 34041, 34042, 34056, 34058–34061, 34063, and 34064.

33881 (AE-282) POLARIZED ELASTIC FAST-NEUTRON SCATTERING OFF ^{12}C IN THE LOWER MeV-RANGE. I. EXPERIMENTAL PART. Aspelund, O. (Aktiebolaget Atomenergi, Stockholm (Sweden)). May 1967. 53p. Dep. SWED.

A polarization study of low-energy n-^{12}C elastic scattering between 1.062 and 2.243 MeV was performed. Seven complete polarization angular distributions were obtained from experimental finite-geometry left-right ratios. Each energy was observed at six or seven laboratory scattering angles between 30 and 129°, using polarized fast neutrons emitted at θ_1 = 50° (lab. syst.) from the $^7Li(p,n)^7Be$-reaction. Proper corrections were applied for finite-geometry and polarized multiple-scattering effects as well as for the presence of the first-excited state group of fast neutrons in the incident beams. The magnitude of the polarization effects is sufficiently large to ensure the potentialities of ^{12}C as an acceptable fast-neutron polarization analyser in the energy range under consideration. Furthermore, on the basis of the above-mentioned polarization data as well as on the basis of total and differential scattering cross-section data available in current literature, reliable phase shifts were determined. These phase shifts are only in partial agreement with the ones of Wills, Jr. et al., and are in definite disagreement with the extrapolated phases of Meier, Scherrer, and Trumpy. Their energy variations will be predicted in the theoretical part of this contribution. (auth) (Sweden)

33882 (INR–801/VI/PH) IS A $^7_\Lambda Li$ HYPERISOMER POSSIBLE? Pniewski, J.; Szymanski, Z.; Davis, D. H.; Sacton, J. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 22p. Dep.

The possibility of the existence of an isomeric state of $^7_\Lambda Li$ is considered. The conclusion appears to depend crucially on the energy of the excited state $\frac{5}{2}^+$ of $^7_\Lambda Li$. If only the spin-dependent central Λ–N forces are taken into account to explain the splitting of the states in hypernuclei then different values of parameter Δ for different states have to be considered. Tensor and spin-orbit forces might contribute to the explanation of the apparent changes of Δ for different p-shell hypernuclei in their ground and excited states. (auth)

33883 (JINR–P6-3314) UGLOVYE RASPREDELENIYA ZARYAZHENNYKH CHASTITS IZ REAKTSII O^{16} + T V INTERVALE ENERGII OT 0,9 DO 1,7 MeV. (Angular Distribution of Charged

Particles From the Reaction $^{16}O + T$ in the Energy Range of 0.9–1.7 MeV). Kobzev, A. P.; Nedvedyuk, K.; Salatskii, V. I.; Sizov, I. V.; Telezhnikov, S. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1967. 29p. (In Russian). Dep.

Angular distributions and total cross sections of the reactions $^{16}O(t,\alpha_0)^{15}N$, $^{16}O(t,p_0)^{18}O$, and $^{16}O(t,p_1)^{18}O^*$ in the range from 0.9 to 1.7 MeV were measured. The values of the expansion coefficients of the angular distributions according to the Legendre polynomials are given. The resonances corresponding to the levels of compound ^{19}F nucleus with the excitation energies of 12.666, 12.784, 12.830, and 12.965 MeV are found in the total cross sections. (auth)

33884 (LA-3695) ^6Li AND ^7Li DATA IN THE ENDF/B FORMAT. Battat, M. E.; Dudziak, D. J.; LaBauve, R. J. (Los Alamos Scientific Lab., N. Mex.). Mar. 1967. Contract W-7405-eng-36. 39p. Dep. CFSTI.

At the Cross Section Evaluation Working Group (CSEWG) Meeting on June 9–10, 1966, at Brookhaven National Laboratory, the Los Alamos Scientific Laboratory was assigned the responsibility of preparing the data for the isotopes ^6Li and ^7Li for the first version of the Evaluated Nuclear Data File/B (ENDF/B) tape. These data were assembled in the ENDF/B format amd were sent to the Cross Section Evaluation Center (CSEC) at Brookhaven National Laboratory. Most of the data are from the AWRE data file originated by K. Parker of Aldermaston. Values for $\bar{\mu}_{LAB}$ and ξ, along with Legendre coefficients for the elastic scattering angular distributions, were received from H. Alter of Atomics International. Plots of the original AWRE cross section data converted to the ENDF/B format are presented. The ENDF/B listings for the ^6Li and ^7Li data, as they appeared on the first version (approximately February 1967) of the ENDF/B tape, are shown. (auth)

33885 STUDY OF THE REACTIONS (d,α) ON ^{14}N AT $E_d \leq$ 2.2 MeV. Lambert, M.; Beaumevieille, H.; Amokrane, A.; Yaker, M. (Institut d'Etudes Nucleaires, Algiers). Nuovo Cim. (10), 50B: 1-16(July 11, 1967). (In French).

The reactions (d,α_0), (d,α_1), (d,α_2), and (d,α_3) on ^{14}N were studied experimentally in the range from 1 to 2.2 MeV. The angular distributions drawn every 200 keV were analyzed through Legendre polynomials of which the variation of coefficients with energy is presented. This variation, as well as that of the total and differential cross sections, shows that the mechanism of these reactions is mostly that of the compound nucleus. The presence of anomalies at approximately 1.10, 1.7, and 2 MeV suggests the existence of excited states in ^{16}O at 21.70 ± 0.09, 22.22 ± 0.09, and 22.50 ± 0.09 MeV. (auth)

33886 THE REACTION $^{10}B(d,\alpha)^8Be$. REMARK CONCERNING THE SECOND EXCITED LEVEL OF ^8Be. Cadeau, M.; Didier, D.; Duchemin, B.; Laugier, J. P.; Mouilhayrat, G.; Perrault, F.; Sudarovich, J.; Thouvenin, P. (Centre d'Etudes Nucleaires, Paris). Nuovo Cim. (10), 50B: 161-5(July 11, 1967). (In French).

Coincidence spectra of alpha particles emitted in the reaction $^{10}B(d,\alpha)2\alpha$ at deuteron energies of 2.663 and 3 MeV were measured in an attempt to observe the ^8Be level with an excitation energy around 11 MeV. A peak corresponding to an excited state near 11 MeV with a width of 2.6 ± 0.6 MeV was observed. (D.C.W.)

33887 ELASTIC SCATTERING OF 1.5 TO 3.0-MeV DEUTERONS BY ^{12}C, ^{25}Mg, AND ^{27}Al. Wang, W. N.; Lin, E. K.; Hsu, C. C.; Chiao, T.; Chu, C. C. (National Tsing Univ., Taiwan, China). Chin. J. Phys. (Taiwan), 5: 1-6(Apr. 1967).

The elastic scattering of deuterons from ^{12}C, ^{25}Mg, and ^{27}Al was studied at energies of 1.5 to 3.0 MeV. Angular distributions of deuterons elastically scattered from these nuclei were obtained at laboratory energies of 1.5, 2.0, and 2.5 MeV. Excitation functions were measured in two or more angles at 25 keV intervals over the entire energy range. Deviations from Coulomb scattering were observed to be larger in ^{12}C than in ^{25}Mg and ^{27}Al. Resonances were found in ^{12}C at deuteron energies of 1.87, 2.60, and 2.78 MeV, corresponding to the excited states at 11.88, 12.51, and 12.69 MeV in the compound nucleus ^{14}N. (auth)

33888 $^{16}O(n,\alpha)^{13}C$ REACTION AT 14.1 MeV. Hsu, Yuin-chi; Huang, Chia-yi; Chang, Ching-ching; Lin, Song-yung (National Taiwan Univ., Taipei). Chin. J. Phys. (Taiwan), 5: 33-6(Apr. 1967).

Energy and angular distributions of alpha particles in the $^{16}O(n,\alpha)^{13}C$ reaction were obtained at 14.1 MeV by using a Wilson cloud chamber. The well-resolved groups of alpha particles leading to the states of 3.85 MeV, 368 MeV, and 3.08 MeV and the ground of ^{13}C were obtained. The angular distributions for these states were analyzed. For the peak in the backward direction, the heavy particle stripping process was applied. For the peak in the forward direction, two reaction mechanisms were proposed: the knock-on process and the pick-up process. (auth)

33889 CLUSTER STRUCTURE OF EXCITED LEVELS IN ^6He AND ^6Li. Thompson, D. R.; Tang, Y. C. (Univ. of Minnesota, Minneapolis). Phys. Rev. Lett., 19: 87-90(July 10, 1967).

Calculations using the resonating-group method showed that there exist levels in ^6He with excitation energies greater than 2 MeV which have predominantly a ^3H-plus-^3H cluster structure and levels in ^6Li with excitation energies between 3.5 and 10.5 MeV which have predominantly a ^3H-plus-^3He cluster structure. (D.C.W.)

33890 MECHANISM OF LITHIUM-INDUCED NUCLEAR REACTIONS. Bethge, K. (Univ., Heidelberg); Meier-Ewert, K.; Pfeiffer, K.; Bock, R. Phys. Lett., 24B: 663-5(June 26, 1967).

Alpha-particle transfer leading to ^{16}O states was investigated by lithium-induced reactions. It is shown that the compound-nucleus contribution is very small in (^7Li,t) in contrast to (^6Li,d). The strong population of the 6.92-MeV, 2^+ and the 10.35-MeV, 4^+ states in ^{16}O gives evidence for the 4p-4h structure of these levels. (auth)

33891 PROJECTED HARTREE–FOCK CALCULATIONS FOR LIGHT NUCLEI. II. FORM FACTORS OF ^6Li. Bouten, M. (SCK, Mol, Belg.); Bouten, M. C.; van Leuven, P. Nucl. Phys., A100: 105-12(1967).

The form factors for elastic and inelastic scattering of high-energy electrons from ^6Li were calculated using the wavefunctions obtained in the first paper of this series. Although considerable deviation from the experimental data remains, the improvement with respect to the shell-model approximation is significant. (auth)

33892 THE $^{14}N(p,d)^{13}N$ REACTION AT 30 MeV. Kozub, R. L.; Kull, L. A.; Kashy, E. (Michigan State Univ., East Lansing). Nucl. Phys., A99: 540-6(1967).

Energy spectra and angular distributions of deuterons from the $^{14}N(p,d)^{13}N$ reaction were measured at an incident proton energy of 30.3 MeV. The data indicate that the ^{13}N levels at 0.0, 3.51, 7.38, 8.93, and 11.80 MeV correspond to the levels calculated by Cohen and Kurath at excitation energies of 0.0, 3.7, 7.4, 8.7, and 10.6 MeV with J^π of $\frac{1}{2}^-$, $\frac{3}{2}^-$, $\frac{5}{2}^-$, $\frac{1}{2}^-$, and $\frac{3}{2}^-$, respectively. Spectroscopic factors obtained from DWBA analysis of the angular distributions are compared with theoretical predictions of intermediate coupling calculations. In addition, the excitation of positive parity states in this reaction indicates configuration admixtures of 2s–1d shell in the ground state of ^{14}N. (auth)

33893 ASYMMETRIES AND DIFFERENTIAL CROSS SECTIONS FOR THE $^{12}C(\vec{p},d)^{11}C$ AND $^{16}O(\vec{p},d)^{15}O$ REACTIONS INDUCED BY POLARIZED PROTONS. Chant, N. S.; Fisher, P. S.; Scott, D. K. (Nuclear Physics Lab., Oxford). Nucl. Phys., A99: 669-85(1967).

The reactions $^{12}C(p,d)^{11}C$ and $^{16}O(p,d)^{15}O$ were studied using a 30.3-MeV polarized proton beam. Differential cross sections and asymmetries were measured for the deuteron groups corresponding to the ground-state, 2.0-MeV, 4.32-MeV, and 4.81-MeV levels in ^{11}C and the ground-state and 6.16-MeV levels in ^{15}O. These data are compared with distorted-wave Born approximation calculations. Agreement with the measured asymmetries is poor. (auth)

33894 DIFFERENTIAL CROSS SECTIONS FOR $^{12}C(d,p_1)^{13}C$ AND $^{10}B(d,p)^{11*}B$ AT ENERGIES BELOW 3 MeV. Poore, Emery Ray Vaughn Jr. Chapel Hill, N. C., Univ. of North Carolina, 1966. 99p.

Thesis.

A study of the $^{12}C(d,p_1)^{13}C$ (3.09 MeV state) was made at bombarding energies between 0.900 and 2.10 MeV. Angular distributions were measured both on and off resonances in the yield curve for eleven bombarding energies. The angular distributions at 1.690, 1.452, 1.320, and 0.900 MeV show the effect of resonances near these energies. Angular distributions for the $^{10}B(d,p)^{11}B$ reactions leaving ^{11}B in the fourth, sixth, seventh, eighth, ninth, tenth, and eleventh excited states were measured at six bombarding energies between 1.75 and 3.00 MeV. Proton yield curves at $\theta_{LAB} = 90°$ were obtained for bombarding energies between 1.42 and 3.10 MeV. No strong resonances are apparent in the yield curves. The angular distributions for $^{10}B(d,p_{4,5})^{11}B$ (6.76 and 8.92 MeV states) show definite L = 1 angular momentum transfer and the angular distributions for $^{10}B(d,p_{10,11})^{11}B$ (9.19 and 9.28 MeV states) have L = 0 shapes. Angular distributions of the groups p_8, p_7, and p_6 (7.30, 7.99, and 8.57 MeV states, respectively) do not indicate any stripping characteristics. Plane wave, DWBA and Coulomb wave fits were attempted, and a comparison is made of the resulting absolute reduced widths and spectroscopic factors. An examination of PWBA fits versus Q-value and bombarding energy was made. (Disser. Abstr.)

33895 BORON INDUCED TRANSFER REACTIONS. Poth, James Edward. New Haven, Yale Univ., 1966. 233p.

Thesis.

Single-nucleon and deuteron transfer reactions induced by

115.9-MeV ^{11}B beams were observed on ^{12}C, ^{13}C, ^{14}N, ^{15}N, ^{16}O, and ^{20}Ne targets, with the primary objectives of elucidating the reaction mechanisms and extracting information of a spectroscopic nature relevant to the interacting nuclear systems. For each target, data on the (^{11}B,^{10}B) and (^{11}B,^{10}Be) neutron and proton transfer reactions and the (^{11}B,^{9}Be) deuteron transfer reaction are presented, consisting of forward-angle energy spectra of the beryllium and boron products of these reactions and absolute differential cross section measurements for states appearing in the spectra. All transfer reactions are observed to exhibit highly selective population of a relatively small number of final states, and evidence is presented that direct transfer represents the dominant mechanism. These reactions are further characterized by a preferential population of certain of these states, with yields large relative to all others in the same spectrum. The (^{11}B,^{10}B) and (^{11}B,^{10}Be) single-nucleon transfer reaction data are consistent with the preferential population of states of a common single-particle configuration. The levels preferentially populated in the (^{11}B,^{9}Be) deuteron transfer reactions are the previously observed giant excitations of the deuteron transfer reaction and are associated with high angular momentum states of extremely pure two-particle configuration. The giant excitations of the reactions studied are interpreted on the basis of simple angular momentum arguments in terms of the capture of the transferred nucleons into $d_{\frac{5}{2}}$ and $f_{\frac{7}{2}}$ single-particle states. A systematic comparison of equivalent (α,d) and (^{11}B,^{9}Be) reactions reveals a high degree of similarity regarding both selective and preferential population of final states, including an unexpected similarity of the isobaric-spin configurations. The consistency of the integrated cross sections of the giant excitations of the two reactions and the equivalence of the corresponding angular distributions indicate an identical direct transfer mechanism. The mass dependence of the cross sections can be interpreted in terms of the shell structure of the respective target nuclei. Ratios of neutron and proton transfer cross sections to analog states in the final systems of the (^{11}B,^{10}B) and (^{11}B,^{10}Be) reactions are utilized in the extraction of relative spectroscopic factors for the incident systems, and these data are used to obtain the (^{10}B + n) and (^{10}Be + p) parentage of the ^{11}B ground state. Calculations of the corresponding ratios and parentage based on available model wavefunctions are in good accord with the experimental results. A particle identification system developed for this work based on the dE/dx and E method and a multiparameter analyzer is described. A semiempirical method for the calculation of energy loss for heavy ions was developed and is shown to be in agreement with available stopping power data. Suggested experimental extensions of these studies are given. (Disser. Abstr.)

33896 $^{19}F(t,\alpha)^{18}O$ REACTIONS. Cameron, Louis McDuffy. Washington, D. C., Georgetown Univ., 1966. 146p.

Thesis.

Differential cross sections were measured as functions of angle and bombarding energy in the region from 1.00 to 2.00 MeV for the following reactions: $^{19}F(t,t)^{19}F$; and $^{19}F(t,\alpha)^{18}O$ going to the ground state, the 1.980 MeV state, and the 3.92 MeV state in ^{18}O. Thin CaF_2 targets on carbon backings were used, and the reaction products were measured with silicon surface barrier detectors. The total cross sections for the $^{19}F(t,\alpha_0)^{18}O$, $^{19}F(t,\alpha_{1.980})^{18}O$, and $^{19}F(t,\alpha_{3.92})^{18}O$ reactions at 1.40, 1.80, and 2.00 MeV are: 0.304, 0.813, and 1.14 mb; 0.58, 1.21, and 1.74 mb; and 0.44, 1.34, and 2.58 mb, respectively. The energy and angular behavior of the differential cross sections suggest that these reactions proceed predominantly by direct interactions. The experimental results for the $^{19}F(t,\alpha)^{18}O$ reactions at 2.00 MeV bombarding energy were analyzed by means of the distorted wave Born approximations using the entrance channel optical model parameters determined from the $^{19}F(t,t)^{19}F$ experiment. These optical parameters obtained by using a modified form of program ELSA, which employs a Saxon-Wood type potential, are: U = 185 MeV; W = 33 MeV; R = 1.23 f.; and a = 0.67 f. The DWBA calculations provide satisfactory fits to the $^{19}F(t,\alpha)^{18}O$ reactions at 2.00 MeV bombarding energy. The exit channel parameters obtained from these theoretical calculations are given. (Disser. Abstr.)

33897 THE POLARIZATION OF PROTONS ELASTICALLY SCATTERED BY ^{12}C. Terrell, Glen Edward. Austin, Univ. of Texas, 1966. 99p.

Thesis.

Double scattering techniques were used to measure the proton spin polarization produced in the elastic scattering of protons by ^{12}C. In each polarization measurement, the protons were elastically scattered by two self supporting C targets. A technique for supporting the foils of 0.6 and 12.0 mg/cm^2 is described in detail. An experimental technique was developed and is described which nullifies exactly or greatly reduces certain sources of instrumental effects on the asymmetries measured in double scattering experiments. Absolute polarization of protons from $^{12}C(p,p)^{12}C$ was measured to an accuracy of about 2% at five points. These measurements were made at angles and energies such that they could be compared with earlier measurements made by a Wisconsin group using a ^4He analyzer. The two sets of data are consistent. Angular distributions of both the polarization and the elastic scattering differential cross section were measured at E_p = 5.41, 5.78, and 5.89 MeV. The first and third of these energies are on resonances in the $^{12}C(p,p)^{12}C$ spectrum. A complex phase shift analysis of this data and the results of an identical analysis of similar data at neighboring energies by a Wisconsin group was used to confirm the assignments of $J^\pi = \frac{3}{2}^+$ and $\frac{5}{2}^-$ to the resonances near E_p = 5.41 and 5.89, respectively. The magnitude of the polarization produced in $^{12}C(p,p)^{12}C$ at $50°_{lab}$ and in the proton energy region 5.4 to 6.4 MeV is large and a slowly varying function of both energy and angle. This fact was put to advantage by using a thick second target (≈10.0 mg/cm^2) and large solid angles in the second scattering to make high resolution measurements of the polarization produced in the region of an anomaly near E_p = 9.13 MeV. The effective polarization produced in the second scattering was measured as a function of the energy of the protons incident on the second target. By using this calibrated polarimeter, it is possible to use relatively thin targets (≈20 keV) and very good angular resolution (±0.8°) in the first scattering and still maintain a reasonable counting rate. The calibrated polarimeter was used to measure polarization angular distributions at E_p = 8.90, 9.15, and 9.6 MeV and polarization excitation functions at $\theta_{c.m.}$ = 51.1 and 133.7°. Angular distributions of the differential elastic scattering cross section were measured at the above energies, and excitation functions of the cross section were measured at $\theta_{c.m.}$ = 51.1, 140.8, and 161.1°. The results of a complex phase shift analysis of all these data revealed that the 9.13-MeV anomaly is a doublet characterized by $J^\pi = \frac{5}{2}^-, \frac{7}{2}^-$. The analysis also indicates that the resonant energies for the two F waves do not differ by more than 2 keV. That both F waves resonate at the same (or almost the same) energy may be of theoretical importance since the average level spacing for several MeV below this anomaly is on the order of 400 keV. (Disser. Abstr.)

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Refer also to abstracts 33602, 33871, 33872, 33887, 33895, 33963, 33964, 33966, 33985, 33986, 34008, 34023, 34031, 34037, 34041, 34042, 34047, 34048, 34055, 34058, 34059, and 34062.

33898 (AD–654153) ENERGY LEVELS IN ^{23}Na. Dubois, J. (California Inst. of Tech., Pasadena). Apr. 1967. 14p.

The energy levels in ^{23}Na were investigated by means of the reaction $^{25}Mg(d,\alpha)^{23}Na$. Deuterons with energy of 10.0 MeV were accelerated with the ONR-CIT tandem accelerator, and the reaction products were analyzed with a double-focusing magnetic spectrometer at 20, 30, and 60°. The level density agrees with that for ^{23}Mg. No evidence for levels at 2.405 and 2.870 MeV in ^{23}Na was found. (auth)

33899 (AD–654155) A STUDY OF LEVELS IN ^{23}Mg. Dubois, J.; Earwaker, L. G. (California Inst. of Tech., Pasadena). Apr. 1967. 51p.

Levels in ^{23}Mg with excitation energies up to 6.8 MeV were investigated by magnetic analysis of the α particles from the reaction $^{24}Mg(^3He,\alpha)^{23}Mg$ at bombarding energies between 6 and 12 MeV. Between 4.4- and 6.8-MeV excitation energy, 16 new levels were found in ^{23}Mg. Angular distributions of the emitted α particles were measured, and from DWBA analysis l-values for the picked up neutrons were obtained. The particle-γ angular correlation method of Litherland and Ferguson was used to obtain additional information on the spin assignments of the levels as well as branching and mixing ratios of the γ-ray transitions. The following spin and parity assignments were established: 0.451 MeV $\frac{5}{2}^+$, 2.048 MeV $\frac{1}{2}$ ($\frac{1}{2}$), 2.356 MeV $\frac{1}{2}^+$, 2.768 MeV ($\frac{1}{2}$, $\frac{3}{2}$)$^-$, 2.904 MeV ($\frac{3}{2}$, $\frac{5}{2}$)$^+$, 3.792 MeV $\frac{3}{2}^-$, 4.353 MeV $\frac{1}{2}^+$, 5.289 MeV ($\frac{3}{2}$, $\frac{5}{2}$)$^+$, and 5.992 MeV ($\frac{1}{2}$, $\frac{3}{2}$)$^-$. The experimental results are compared with those obtained for ^{23}Na and with the predictions of the collective model. (auth)

33900 (AD–654156) NUCLEAR ENERGY LEVELS OF ^{37}K. Goosman, D. R.; Kavanagh, R. W. (California Inst. of Tech., Pasadena). Apr. 1967. 103p.

Approximately forty levels in ^{37}K were established via the reactions $^{40}Ca(p,\alpha)^{37}K$, $^{36}Ar(p,p)^{36}Ar$, $^{36}Ar(p,\gamma)^{37}K$, $^{36}Ar(p,p'\gamma)^{36}Ar$, $^{36}Ar(d,n)^{37}K$, and $^{34}Ar(^3He,d)^{37}K$. Measurements of capture-gamma-ray energies with Ge(Li) counters have made possible the determina-

tion of several level energies with precisions ranging from 1 to 5 keV. The analogs in ^{37}K of the first two excited levels in ^{37}Ar were found as a closely spaced doublet at 1368- and 1380-keV excitation energy. The half-life of the latter was measured electronically to be 9.6 ± 1.4 nsec. The energies (in keV), spins, and parities of the lowest eight levels are 0, $\frac{3}{2}^+$; 1368 ± 3, $(\frac{1}{2}^+)$; 1380 ± 2, $\frac{1}{2}^-$; 2169 ± 5, $(\frac{3}{2}^-)$; 2278 ± 9 ... ; 2750 ± 1, $\frac{5}{2}^+$; 3083 ± 4, $(\frac{5}{2}^-)$; and 3311 ± 4, $\frac{1}{2}^-$. Spin and parity assignments to other levels are also presented. Approximate values for the elastic and inelastic proton and gamma-ray widths of several levels were determined. Evidence regarding the spins, parities, and widths of two candidates (at 5018 ± 3 and 5048 ± 3 keV) for the lowest T = $\frac{1}{2}$ level is presented. The Q-value for ^{36}Ar(p,γ) is 1857.0 ± 1.4 keV, and the mass excess of ^{37}K on the ^{12}C = 0 scale is −24799.6 ± 2.7 keV. (auth)

33901 (ANL-7289) STUDIES OF LOW-ENERGY NUCLEAR REACTIONS AND LEVEL DENSITIES FOR MEDIUM-MASS NUCLEI. Katsanos, Anastasios A. (Argonne National Lab., Ill.). Jan. 1967. Contract W-31-109-eng-38. 100p. Dep. CFSTI.

Thesis.

The level densities of ^{52}Cr, ^{56}Fe, and ^{32}S were investigated in a range of excitation energy up to about 20 MeV. The energy levels of ^{52}Cr and ^{56}Fe up to excitation energies of 6.3 and 6.7 MeV, respectively, were resolved from the reactions ^{52}Cr(p,p′)^{52}Cr, ^{55}Mn(p,α)^{52}Cr, ^{56}Fe(p,p′)^{56}Fe, and ^{59}Co(p,α)^{56}Fe with thin targets. The outgoing particles were analyzed with a single-gap broad-range magnetic spectrograph. By analyses of the spectra in the continuum according to the evaporation theory, the level densities of the residual nuclei, up to an excitation energy of 8 MeV, were calculated. In addition, the excitation functions for the reactions ^{55}Mn(p,α)^{52}Cr, ^{31}P(p,α)^{28}Si, and ^{51}V(p,α)^{48}Ti were obtained from experiments with surface-barrier solid-state detectors; and the average widths of the compound nuclei ^{52}Cr, ^{56}Fe, and ^{32}S were calculated at excitation energies around 20 MeV. Absolute values of the cross sections for the reactions ^{55}Mn(p,α)^{52}Cr and ^{51}V(p,α)^{48}Ti were also obtained. The experimental widths were compared with values calculated optical-model transmission coefficients. Finally, the level density up to about 20 MeV of excitation energy was calculated for each of the three nuclei. The results are compared with curves derived from the Fermi-gas and constant-temperature models. (D.C.W.)

33902 (LFF-19) AN INVESTIGATION OF THE ^{50}Cr(p,γ)^{51}Mn REACTION. Broman, Lars (Chalmers Tekniska Hogskola, Goteborg (Sweden). Forskningradens Laboratorium, Studsvik (Sweden)). May 15, 1965. 12p. Dep.

The reaction ^{50}Cr(p,γ)^{51}Mn was studied at some resonances. Energies of bound levels at 240 ± 3, 1827 ± 5, 1964 ± 5, 2150 ± 10, 2255 ± 5, 2320 ± 15, 2844 ± 10 and 2920 ± 10 keV are given with smaller errors than before. Previously unreported levels are suggested at 2430 ± 10, 2515 ± 15, 3166 ± 15, 3290 ± 15, and 3335 ± 10 keV. The Q-value of the reaction is determined to 5291 ± 7 keV. (auth)

33903 (NP-16747) PROPERTIES OF SOME ^{25}Mg ENERGY LEVELS. McCallum, G. J.; Sowerby, B. D. (Australian National Univ., Canberra. Research School of Physical Sciences). [1964]. 9p. DTIE.

The energy levels of ^{25}Mg were investigated using proton inelastic scattering and the reaction ^{22}Ne(α,nγ)^{25}Mg. The branching ratios of the third to the eighth excited states; the multipole mixing ratios of the 1.962 → 0, 1.962 → 0.976, and 3.399 → 1.611 MeV transitions; and the spins and parities of the 1.611-, and 2.736-, and 3.399-MeV levels were determined. (D.C.W.)

33904 (ORO-3346-10) STUDIES OF THE M/L ORBITAL ELECTRON CAPTURE RATIO IN ^{37}Ar DECAY. Renier, Jean-Paul A. (Georgia Inst. of Tech., Atlanta). June 1967. Contract AT(40-1)-3346. 63p. Dep. CFSTI.

Thesis.

Recent investigations of the pulse height distribution from proportional counters due to single- and multiple-electron events make it possible to measure single electron spectra down to essentially zero energy with much greater accuracy than heretofore. The ratio of M- to L-orbital electron capture in the decay of 35-day ^{37}Ar was measured in a single-wire proportional counter containing the gaseous source. This counter was operated with variable paralysis times, 3.8 msec being used in the experiments to minimize the contribution from negative ions. The experiment was undertaken because of the considerable disagreement between experimental and theoretical M/L capture ratios, particularly in the region of low Z. A survey of all experimental work on M-capture is included for comparison with available theoretical results. (S.F.L.)

33905 (WANL-TME-1334) A CHANGE IN THE Ni CROSS SECTIONS FOR THE GAM LIBRARY. Gibson, Gordon; Melnick, M. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Nov. 30, 1965. Contract SNP-1. 30p. Dep. CFSTI.

The neutron elastic scattering matrices P_0 and P_1 for Ni were modified in the GAM library to correct an error in previously added cross sections. The DOODLES program was used to calculate the new cross sections. (S.F.L.)

33906 THE REACTIONS ^{64}Zn(^{3}He,d)^{65}Ga AND ^{64}Zn(^{3}He,α)^{63}Zn. Betigeri, M. G.; Duhm, H. H.; Santo, R.; Stock, R.; Bock, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A100: 416-24(1967).

The reactions ^{64}Zn(^{3}He,d)^{65}Ga and ^{64}Zn(^{3}He,α)^{63}Zn were studied at an incident ^{3}He energy of 18 MeV using a broad-range magnetic spectrograph and an E−dE telescope. Angular distributions were obtained and are analyzed by the DWBA theory. The results give information about the ^{64}Zn ground-state configuration as well as the neutron hole states in ^{63}Zn and the single proton states in ^{65}Ga, respectively. (auth)

33907 RELAXATION AND NUCLEAR MAGNETIC RESONANCE OF POLARIZED β-ACTIVE NUCLEI. Gul'ko, A. D.; Trostin, S. S.; Khudoklin, A. (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz., 52: 1504-16 (June 1967). (In Russian).

The results are presented of an investigation of the asymmetry of the radiation and NMR of polarized β-active nuclei produced by irradiating an unpolarized target by polarized thermal neutrons. The connection between the observed shape of the NMR line and the natural line shape defined by local fields is considered. Polarization values of the ground states of ^{8}Li, ^{20}F, ^{108}Ag, ^{110}Ag, and ^{66}Cu nuclei after capture of a thermal neutron are obtained. The local fields in ^{8}Li nuclei in crystalline ^{7}LiF are derived from the shape of the NMR lines. With lowering of the sample temperature to helium temperature, an increase of asymmetry of the β-radiation from ^{20}F nuclei and a change of the shape of the NMR curve shape in a CaF_2 single crystal were observed. It is shown that the polarized ^{108}Ag and ^{110}Ag β-active nuclei in AgCl crystals consist of two subsystems one of which possesses a large relaxation time and the other a small time. (auth)

33908 THE (^{3}He,α) REACTIONS ON EVEN TITANIUM ISOTOPES. L'Ecuyer, J.; St. Pierre, C. (Laval Univ., Quebec). Nucl. Phys., A100: 401-15(1967).

The angular distributions of the alphas from the reactions ^{46}Ti(^{3}He,α)^{45}Ti, ^{48}Ti(^{3}He,α)^{47}Ti, and ^{50}Ti(^{3}He,α)^{49}Ti were measured at $E_{^3He}$ = 10 MeV. A number of l_n = 3 transitions, corresponding to the pick-up of neutrons from the $1f_{\frac{7}{2}}$ shell, was observed. l_n = 0 and 2 transitions were also found indicating that the pick-up can also originate from the $2s_{\frac{1}{2}}$ and $1d_{\frac{3}{2}}$ shell. Finally some l_n = 1 transitions were observed, indicating p-wave admixture in the ground state of the even titanium isotopes. Spectroscopic factors were deduced for the various transitions by means of a DWBA analysis. The experimental results were compared with the theoretical predictions of the shell model and of the rotational model with Coriolis coupling. (auth)

33909 THE REACTION ^{26}Mg(p,γ)^{27}Al. I. EXCITATION ENERGIES AND BRANCHING OF ^{27}Al LEVELS. van der Leun, C.; Sheppard, D. M.; Endt, P. M. (Rijksuniversiteit, Utrecht). Nucl. Phys., A100: 316-32(1967).

The gamma spectra of thirty ^{26}Mg(p,γ)^{27}Al resonances in the range E_p = 0.3 to 2.8 MeV were measured with a 20-cm^3 Ge(Li) detector. Internal calibration, based only on the reaction Q-value and the 511-keV annihilation line, leads to level energies with a precision ranging from a few tenths of a keV for the lower levels to 2 or 3 keV for the higher levels. Branching ratios are reported for the thirty resonance levels and most of the known bound states. A remarkable grouping of resonances which strongly decay to highly excited ($E_x \approx 6$ to 7 MeV) bound states suggests some form of intermediate structure even at the widely spaced low-energy resonances; it can be described only partly in terms of isobaric analog states. (auth)

33910 THE REACTION ^{26}Mg(p,γ)^{27}Al. II. SPINS OF ^{27}Al LEVELS. Sheppard, D. M.; van der Leun, C. (Rijksuniversiteit, Utrecht). Nucl. Phys., A100: 330-50(1967).

Measurements of double and triple angular correlations and gamma-ray polarizations at twenty resonances in the reaction ^{26}Mg(p,γ)^{27}Al, lead to the unambiguous spin and parity assignments $J^\pi = \frac{1}{2}^+, \frac{5}{2}^+, \frac{3}{2}^+, \frac{9}{2}^+$, and $\frac{5}{2}$ to the bound states of ^{27}Al at 2.21, 2.73, 2.98, 3.00, and 4.81 MeV, respectively. The 6.48-MeV level has $J = \frac{7}{2}(\frac{5}{2})$. The quadrupole/dipole amplitude mixing ratios of the gamma rays de-exciting these levels are given. The spins of 15 resonance levels and the mixing ratios of the main branches in the resonance decay also follow from this experiment. The combined evidence of the decay of the resonance levels and bound states leads to suggested spin values $J = (\frac{1}{2},\frac{3}{2})$, $\frac{3}{2}$, $(\frac{1}{2},\frac{3}{2})$, $\frac{5}{2}$, $\frac{5}{2}$, $(\frac{3}{2},\frac{5}{2})$, $\frac{3}{2}$, $\frac{3}{2}$, $\frac{3}{2}$ and $\frac{5}{2}$ for ^{27}Al* = 3.68, 3.96, 4.05, 4.41, 5.25, 6.11, 6.16, 6.61, 6.65, and 6.78 MeV, respectively. (auth)

33911 ANGULAR DISTRIBUTIONS FOR THE INVERSE PHOTONUCLEAR PROCESS IN ^{28}Si IN THE EIGENCHANNEL REACTION THEORY. Wahsweiler, H. G.; Greiner, Walter (Univ., Frankfurt am Main). Phys. Rev. Lett., 19: 131-4 (July 17, 1967).

Using the eigenchannel reaction theory, coupled-channel calculations were performed for ^{28}Si, and the differential cross section for ^{27}Al(p,γ_0)^{28}Si was calculated over the energy range 6 MeV < E_p < 16 MeV. The angular distributions obtained are nearly constant over the whole energy range and agree with the experiment in that they are almost isotropic. Thus, it seems that in this framework a natural explanation can be given for the peculiar behavior of the ^{27}Al(p,γ_0)^{28}Si cross section. (auth)

33912 ABSOLUTE LEVEL DENSITIES FROM NEUTRON INELASTIC SCATTERING. Towle, J. H.; Owens, R. O. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Phys., A100: 257-79(1967).

The spectra of neutrons inelastically scattered from Na, Al, K, Cr, Fe, ^{58}Ni, and ^{60}Ni were measured for 7-MeV incident neutrons. For the nuclei ^{56}Fe and ^{60}Ni, statistical-model calculations were made to predict the complete spectrum of scattering to the known discrete levels below about 3.5 MeV, together with a continuum of higher levels described by the level density formula $\omega(U) = KU^{-2} \exp 2\sqrt{aU}$. By fitting the theoretical spectrum to the experimental one, the constants K and a were both obtained, thus determining the absolute level density in the continuum in addition to its variation with excitation energy. The results indicate that the nuclear moments of inertia of ^{56}Fe and ^{60}Ni have approximately the rigid-body value. Evidence is also presented for strong direct components in the scattering to the first levels in ^{23}Na and ^{27}Al and to the first 2^+ level and 3^- collective states in ^{52}Cr, ^{56}Fe, ^{58}Ni, and ^{60}Ni. (auth)

33913 THE ^{50}Cr(^{3}He,d)^{51}Mn REACTION. Rapaport, J.; Belote, T. A.; Dorenbusch, W. E. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys., A100: 280-96(1967). (MIT-2098-328).

The reaction ^{50}Cr(^{3}He,d)^{51}Mn was investigated at 12.0-MeV bombarding energy using the MIT multiple-angle spectrograph. A DWBA analysis was carried out on the angular-distribution data for 29 levels below 5.7 MeV of excitation to determine l_p values and spectroscopic strengths. The transition to the $^5/_2^-$ ground state is compared with shell-model forbidden $^5/_2^-$ transitions to ^{47}V, ^{51}V and ^{53}Mn. The level structure of ^{51}Mn is compared with shell-model calculations. The analog-state transitions are compared with the ^{50}Cr(d,p)^{51}Cr results. (auth)

33914 THE AKHIESER-POMERANCHUK-BLAIR MODEL ANALYSIS OF ELASTIC SCATTERING OF ALPHA PARTICLES FROM THE NUCLEI Co, Ni, Mn, Ca, Al, Mg, AND Ne. Rahman, M. (Atomic Energy Centre, Dacca, Pakistan); Khan, A. H.; Sen Gupta, H. M. Nuovo Cim. (10), 50B: 40-7(July 11, 1967). (AECD/TP-14).

Measured angular distributions of 24.7-MeV alpha particles elastically scattered from Co, Mn, Ni, Ca, Al, and Mg and 20.9-MeV alpha particles from Ne were analyzed in terms of the smoothed Akhieser-Pomeranchuk-Blair model. A good agreement was found in most cases up to about 90° and in some cases beyond; agreement is comparatively poor in Ca, Mg, and Ne. The interaction radius and surface diffuseness were obtained from the best-fit parameters of the analyses. (auth)

33915 DISTORTED-WAVE ANALYSIS OF INELASTIC SCATTERING OF 61.7 MeV PROTONS FROM ^{60}Ni. Bertrand, F. E.; Dickens, J. K.; Love, T. A. (Oak Ridge National Lab., Tenn.). Phys. Lett., 24B: 653-5(June 26, 1967). (ORNL-P-3109).

Differential cross sections for the scattering of 61.7-MeV protons from the first excited state (E_x = 1.33 MeV) of ^{60}Ni were measured between 15 and 40° with an experimental resolution of 0.3%. The data are reproduced well by a distorted-wave calculation using the vibrational model with $\beta = 0.20$. (auth)

33916 QUASI-ELASTIC (^{3}He,t) SCATTERING FROM THE TITANIUM ISOTOPES. Roos, P. G. (Oak Ridge National Lab., Tenn.); Ludemann, C. A.; Wesolowski, J. J. Phys. Lett., 24B: 656-8(June 26, 1967). (ORNL-P-3126).

The (^{3}He,t) reaction to the isobaric analogues of all the Ti isotope ground states was investigated with 24.6-MeV ^{3}He ions. Coulomb displacement energies are given, and the measured cross sections are compared with the predicted (N-Z) dependence. (auth)

33917 ISOMERIC TRANSITIONS IN ^{43}Sc AND ^{46}V. Conlon, T. W. (Princeton Univ., N. J.). Phys. Lett., 24B: 661-2 (June 26, 1967). (PUC-937-239).

A survey was made to look for isomeric states with half lives in the range 10 μsec to 30 msec produced by 17.5-MeV proton bombardment of the $1f_{\frac{7}{2}}$ shell elements Ca to Co. Isomers were observed in ^{43}Sc and ^{46}V nuclei; in each case, the state decays with the emission of a single γ ray. The reactions leading to the ^{43}Sc isomer are ^{46}Ti(p,α)^{43}Sc, ^{43}Ca(p,n)^{43}Sc, and ^{44}Ca(p,2n)^{43}Sc, and, leading to the ^{46}V isomer, ^{46}Ti(p,n)^{46}V. The energies and half lives of these transitions are for ^{43}Sc and ^{46}V, respectively, 151.9 keV, 421 μsec and 801.1 keV, 1040 μsec. A 5-msec isomer reported in ^{45}Ti was shown to be due to impurities in the Sc target used in its excitation. (auth)

33918 DISTURBANCE OF RESONANT SCATTERING OF γ RAYS FROM A ^{79}Kr SOURCE ON ^{79}Br BY GAS KINETIC COLLISIONS IN THE SOURCE. Schoett, W.; Langhoff, H.; Frevert, L.; Flammersfeld, A. (Univ., Goettingen, Ger.). Z Phys., 203: 443-52(1967). (In German).

The γ quanta emitted by gaseous ^{79}Kr-sources were scattered resonantly from ^{79}Br nuclei. By increasing the density in the source, the effective cross section for resonance scattering was influenced due to gas-kinetic collisions of the recoiling ^{79}Br nuclei with atoms before emission of the γ quantum. The cross section for gas-kinetic collisions was determined to be $\sigma_{st} = 12.0 \pm 1.8 \times 10^{-16}$ cm^2 in agreement with the theoretical value obtained from a hard-sphere model. This technique, similar to the usual Doppler-shift technique, yields, if combined with the measurement of the absolute cross section for resonance scattering, spins and lifetimes of the levels at 398 and 606 keV. The resonance scattering from the 834-keV level shows an unexpected behavior in complete contradiction to the hard-sphere model, indicating that the velocity of the recoiling nuclei is increased in a dense source atmosphere. (auth)

33919 RESONANCES IN THE REACTION ^{36}S(p,γ)^{37}Cl. Ievlev, Yu. P.; Koval', A. A.; Kopanets, E. G.; Korda, Yu. S.; Sukhotin, L. N.; Tsytko, S. P. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 12: 747-53(May 1967). (In Russian).

The function stimulating the reaction ^{36}S(p,γ)^{37}Cl over the range E_p = 2050 to 3200 keV is studied. "Resonance forces" are determined for some levels. Squares of matrix elements are calculated in Weisskopf's units for transitions into the main state of the ^{37}Cl nucleus. (auth)

33920 ANGULAR DISTRIBUTIONS OF ^{64}Cu RECOIL NUCLEI IN THE REACTION ^{65}Cu(γ,n)^{64}Cu. Denisov, F. P.; Duisebaev, A.; Cherenkov, P. A. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 5: 200(Apr. 15, 1967).

Translated from Zh. Eksp. Teoret. Fiz., Pis'ma Redakt., 5: 249-50(Apr. 15, 1967).

Targets of Cu enriched in ^{65}Cu were exposed to bremsstrahlung with a maximum end-point energy of 260 MeV, and the angular distribution of the ^{64}Cu recoil nuclei was measured from 30 to 150° in the laboratory system. The results show that the ^{64}Cu nuclei are emitted predominantly in the forward direction with respect to the bremsstrahlung beam. The maximum of the angular distribution is at 45°, and the yield of ^{64}Cu nuclei at 45° is approximately twice the yield at 135°. The anisotropy in the angular distribution indicates that the direct-interaction mechanism plays an appreciable role in photon absorption by the ^{65}Cu nucleus. (D.C.W.)

33921 SEARCH FOR 2p-1h CONFIGURATIONS IN MIRROR NUCLEI ^{41}Ca AND ^{41}Sc. Beuzit, P.; Cassagnou, Y.; Cindro, N.; Cotton, E.; Delaunay, J.; Fouan, J. P.; Papineau, L. (CEN, Saclay, France). Phys. Rev. Lett., 19: 94-6(July 10, 1967).

Excitation functions for proton elastic and inelastic scattering by ^{40}Ca were measured in an attempt to identify in ^{41}Sc the analogs of 2p-1h states in ^{41}Ca. (D.C.W.)

33922 REVISED A-CHAINS AND ADJUSTED MASS DIFFERENCES FOR A = 70 TO 76. Nucl. Data, Sect. B, 1: B1-6-1-132 (Dec. 1966).

Data sheets are given for energy level schemes for nuclei with $70 \leq A \leq 76$. The "most probable" spin and parity assignments for as many levels as possible are given with indications of the strongest reasons known at present for each assignment. (S.F.L.)

33923 REVIEW OF THE ^{47}V → ^{47}Ti BETA DECAY. Rosner, Baruch; Broman, Lars (Univ. of Pennsylvania, Philadelphia). Nucl. Phys., A100: 59-64(1967).

The gamma activity following the bombardment of ^{47}Ti with 4.5-MeV protons was investigated by means of a 17-cc Ge(Li) detector. The following gamma transitions were attributed to the 31-min decay of ^{47}V and were fitted into a decay scheme: 160.9 ± 3.0, 1391.4 ± 1.2, 1552.3 ± 2.4, 1794.9 ± 0.8, and 2163.0 ± 1.2 keV. The transition strengths have provided new spectroscopic information about the ^{47}Ti level scheme. The results are discussed in view of the new $^3/_2^-$ spin-parity assignment to the ^{47}V ground state. (auth)

33924 FAST NEUTRON CAPTURE GAMMA-RAY SPECTRA IN Rb, Sr, Y, Zr, AND Nb. Lundberg, B.; Starfelt, N. (Fors-

varets Forskningsanstalt, Stockholm). Ark. Fys., 33: 1, 37-47(1967).

Gamma spectra emitted in the capture of 0.05-, 1.0-, and 1.5-MeV neutrons in Rb, Y, Zr, and Nb and 0.05-MeV neutrons in Sr were measured. The shapes of the gamma spectra depend on neutron energy in a way not observed in the studies of heavier elements. Comparison with theory was attempted but no new conclusions about the neutron capture mechanism can be derived from the present results. (auth)

33925 THE $^{40}Ar(n,\gamma)^{41}Ar$ REACTION. Lycklama, H.; Archer, N. P.; Kennett, T. J. (McMaster Univ., Hamilton, Can.). Nucl. Phys., A100: 33-44(1967).

The gamma radiation emitted following neutron capture in natural argon was studied. A neutron separation energy of 6098 ± 2 keV was found for ^{41}Ar. From energy, intensity, and coincidence measurements, a decay scheme was constructed which included all of the 25 observed transitions. Comparison of the (n,γ) reduced widths with the (d,p) spectroscopic factor $S = (2J_f + 1)\theta^2$ for eight $l_n = 1$ levels indicated that the quantity $\bar{\gamma}/\theta^2$ is highly correlated ($\rho = +0.97$). A much lower correlation ($\rho = +0.42$) is obtained for the quantity $\bar{\gamma}/(2J_f + 1)\theta^2$ which is expected to represent the relation between the two reaction mechanisms. (auth)

33926 ORBITAL ELECTRON CAPTURES IN ^{51}Cr AND ^{65}Zn AND THE K-FLUORESCENCE YIELDS OF V AND Cu. Mukerji, Ambuj; McGough, James B. Jr.; Cole, George D. (Univ. of Alabama, University). Nucl. Phys., A100: 81-9(1967).

The rates of production of K x rays during the decay of the radioactive nuclei ^{51}Cr and ^{65}Zn were determined by measuring coincidences $N_{K-\gamma}$ between the K x ray and the 323-keV gamma ray in the case of ^{51}Cr and between the K x ray and the 1.114-MeV gamma ray for ^{65}Zn. The total electron capture rate was obtained in each case by recording the number of pulses due to the gamma ray in the selection channel N_γ. For each of the nuclei, the ratio of the two measured quantities $N_{K-\gamma}$ and N_γ, when compared with the theoretical ratio of K-capture rate to the rate of capture from all the shells corrected for exchange and overlap, yields the value of the corresponding K fluorescence yield ω_K. The values of ω_K thus determined are $\omega_K(V) = 0.221 \pm 0.018$ and $\omega_K(Cu) = 0.436 \pm 0.030$. These values are compared with the values obtained from semi-empirical relations. (auth)

33927 CALCULATED LEVEL DENSITIES IN LIGHT NUCLEI. Stewart, K. W. C. (Univ. of Glasgow). Nucl. Phys., A100: 74-80(1967).

Level densities of nuclei of A = 20 and 22 are calculated in a simplified shell-model situation. An oscillator potential is used with a residual interaction involving space-exchange and quadrupole-quadrupole forces. Relative level densities of different isobars are found to be dominated by the effect of the symmetry force and to bear good resemblance to the available experimental information. The angular momentum distribution of states is in good agreement with previous statistical models. (auth)

33928 THE DECAY OF ^{57}Ni. Lingeman, E. W. A.; Konijn, J.; Diederix, F.; Meijer, B. J. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., A100: 136-44(1967).

The energies and relative intensities of the gamma radiations following the decay of ^{57}Ni to ^{57}Co were measured using a lithium-drifted germanium detector. Gamma rays of the following energies in keV were observed (relative intensities in parentheses): 3177.3 (0.021); 3151(0.010); 2805.1(0.088); 2731(0.015); 1919.9(22.4); 1758.2(9.5); 1378.0(100), and 127.6(17.6). Upper limits for relative intensities of other possible gamma rays are given. Spin and parity assignments for levels in ^{57}Co were made. No evidence was found for earlier reported levels at 1.46, 1.59 and 2.62 MeV. The total disintegration energy of ^{57}Ni is calculated to be 3246 ± 9 keV. (auth)

33929 MEASUREMENTS ON NEUTRON CROSS SECTIONS AND ISOMERIC CROSS SECTION RATIOS IN Se ISOTOPES. Minetti, B.; Pasquarelli, A. Nucl. Phys., A100: 186-90(1967).

The activation cross sections of 14.7 MeV neutron-induced reactions were measured in Se isotopes. The experimental results were compared with the predictions of the statistical theory of the compound nucleus. For some reactions it was possible to determine the isomeric ratios; these ratios were analyzed using the statistical calculation of Huizenga and Vandenbosch, and estimates were obtained for the parameter σ which characterizes the spin dependence of the nuclear level density. (auth)

33930 THE DWBA AND SPIN-ORBIT EFFECTS IN THE $^{46,48}Ti$, $^{50,52}Cr(d,p)$ REACTIONS. Alty, J. L.; Green, L. L.; Jones, G. D.; Sharpey-Schafer, J. F. (Univ. of Liverpool). Nucl. Phys., A100: 191-224(1967).

Differential cross sections were measured in the ^{46}Ti, ^{48}Ti, $^{50}Cr(d,p)^{47}Ti$, ^{49}Ti, ^{51}Cr reactions at a deuteron bombarding energy of 9.15 MeV. The angular distributions for l = 1 states at large angles differ for $2p_{\frac{3}{2}}$ and $2p_{\frac{1}{2}}$ single particle states. Differences in the angular distributions with l = 3 are observed and attributed to the final state being either $1f_{\frac{5}{2}}$ or $1f_{\frac{7}{2}}$. DWBA calculations with spin-orbit terms in the deuteron, proton, and neutron channels and finite-range and nonlocal corrections are made in an attempt to reproduce the observed j-dependence. Deuteron optical-model parameters including the spin-orbit terms are derived by making best fits to the relevant elastic scattering data. It is found that the DWBA calculations produce a j-effect for $2p_{\frac{3}{2}}$ and $2p_{\frac{1}{2}}$ configurations that is qualitatively the same as that observed experimentally but does not have the correct magnitude. The calculated difference between states with $1f_{\frac{5}{2}}$ and $1f_{\frac{7}{2}}$ configurations is opposite to that suggested experimentally. The difficulties in selecting a unique deuteron potential are not resolved by the inclusion of spin-orbit terms in the DWBA. (auth)

33931 ASYMMETRY IN ISOBARIC ANALOGUE RESONANCES IN THE $^{75}As(p,n)$ REACTION. Fan, C.; Paul, E. B. (Rice Univ., Houston, Tex.). Nucl. Phys., A100: 168-76(1967). (ORO-1316-33).

The excitation function for $^{75}As(p,n)$ was measured at proton energies between 2.00 and 5.00 MeV. Resonances were observed, and strong asymmetries were observed in the peaks at $E_p = 4.47$ and 4.58 MeV. These asymmetric resonant peaks were analyzed using the Kim-Robinson formula for a (p,n) reaction involving isobaric analogue resonances. With the assumption of a statistical model and random phases, the absolute cross section is obtained. The asymmetry parameters are found to be $\Delta = -158$ keV for $E_p = 4.47$ and $\Delta = -82$ keV for $E_p = 4.58$ MeV. (auth)

33932 DEUTERON ELASTIC SCATTERING AT 34.4 MeV. Newman, E. (Oak Ridge National Lab., Tenn.); Becker, L. C.; Preedom, B. M.; Hiebert, J. Nucl. Phys., A100: 225-35(1967). (ORNL-P-2973).

Differential cross sections were measured for the elastic scattering of 34.4-MeV deuterons from 18 nuclei in the A = 12 to 96 region. An optical-model analysis of the data was made both with and without a vector spin-orbit term in the potential. Including the spin-orbit term resulted in essentially no improvement of the fits for ^{12}C and ^{16}O in the angular range studied. For the heavier targets, however, the spin-orbit potential did improve the quality of the fits. From "best-fit" parameters for each nucleus, an "average" family was obtained as a function of Z and A. Comparison of the data with predictions using the average parameters gave generally satisfactory results. (auth)

33933 THE NEGATON SPECTRUM OF ^{36}Cl. Spejewski, E. H.; Willett, J. B. (Indiana Univ., Bloomington). Contract NONR-1705(02). Nucl. Phys., A99: 625-32(1967).

The shape of the twice-forbidden negaton spectrum of ^{36}Cl was measured in a 4π semiconductor spectrometer. It was not possible to fit the data with the normal approximation to the theoretical shape factor, $L_0q^2 + 9\lambda^2L_1$, for any value of the parameter λ^2. By including all terms in the theoretical shape factor to one higher order in the nuclear radius, it was possible to obtain an excellent fit to the data using the reduced matrix elements as parameters. The endpoint of the spectrum was determined to be 708.7 ± 0.6 keV. (auth)

33934 ON THE EXCITED STATES OF ^{61}Ni. Beraud, R.; Berkes, I.; Daniere, J.; Levy, Michele; Marest, G.; Rougny, R. (Univ., Lyon). Nucl. Phys., A99: 577-84(1967). (In French).

The spectrum of the 3.3-hr decay $^{61}Cu \rightarrow {}^{61}Ni$ was reinvestigated using a Ge(Li) detector. Twenty-two transitions involving 10 excited levels were identified. The energies and relative intensities of the transitions are given. The lifetime of the 283-keV level is determined by a direct time-measurement, $\tau = 32 \pm 6$ ps, and for the 656 keV level, $\tau < 30$ ps. Combining these results with (d,p) reaction, (n,γγ) angular correlation, and Coulomb-excitation data, the following spin and parity values may be established: $\frac{1}{2}^-$ for the 283-keV level, $(\frac{3}{2})^-$ for the 656-keV level, and $\frac{5}{2}^-$ for the 909.8-keV and the 1132-keV levels. (auth)

33935 ABSOLUTE CROSS SECTIONS AND EXCITATION FUNCTIONS FOR DEUTERON-INDUCED REACTIONS ON THE NICKEL ISOTOPES BETWEEN 2 AND 12 MeV. Cogneau, M.; Gilly, L. J.; Cara, J. (Univ., Louvain). Nucl. Phys., A99: 686-94(1967).

Absolute cross sections and excitation functions for the reactions $^{58}Ni(d,n)^{59}Cu$, $^{61}Ni(d,n)^{62}Cu$, $^{62}Ni(d,2n)^{62}Cu$, $^{60}Ni(d,n)^{61}Cu$ and $^{58}Ni(d,t)^{57}Ni$ were measured by activation using the stacked-foil technique. The (d,n) experimental excitation functions are compared to the theoretical calculations of F. Perey based on a nonlocal, optical-model potential. (auth)

33936 A NOTE ON THE DECAY OF ^{44m}Sc. King, J. D.; Neff, N.; Taylor, H. W. (Univ. of Toronto). Can. J. Phys., 45: 2446-53(July 1967).

Taking advantage of the superior resolution of a Ge(Li) detector, improved energy determinations of those levels in ^{44}Ca excited by the decay of ^{44m}Sc were made. Weak gamma transitions at 810 MeV and 2200 MeV previously assigned in this decay scheme were not found in this experiment. Other level differences are also discussed. (F.S.A.)

33937 STUDY OF THE GAMMA RADIATION FOLLOWING NEUTRON CAPTURE IN COPPER. Colenbrander, A. H.; Kennett, T. J. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 45: 2395-2408(July 1967).

The neutron capture gamma-ray spectrum for a natural copper target was investigated using a Ge(Li) spectrometer. A total of 146 gamma rays was observed, of which about half were isotopically assigned. Assignment was achieved through the use of coincidence measurements and (d,p) results. The neutron separation energies were found to be 7,914(3) and 7,063(3) keV for ^{64}Cu and ^{66}Cu, respectively. The ^{66}Cu gamma-ray transition to low-lying states exhibits exceptionally large radiation widths in a manner similar to the corresponding anomaly in ^{64}Cu. (auth)

33938 ON THE SPIN ^{47}V. Akhmed, M. R.; Baskova, K. A.; Vasil'ev, S. S.; Peker, L. K.; Shavtvalov, L. Ya. (Moscow State Univ.). Yadern. Fiz., 5: 1141-4(June 1967). (In Russian).

The spectrum of ^{47}V was measured with the scintillation γ spectrometer. The existence of γ lines with energies of 1540, 1800, and 2160 keV is estimated safely. The results are compared with the data from different nuclear reactions which give the level spectrum of ^{47}V. A conclusion is made about the spin and parity of the ground state of ^{47}V. The spin and parity $5/2^-$, but not $7/2^-$ or $5/2^-$ as one may expect, are established to be most probable. Some reasons for this anomaly are discussed. (auth)

33939 LEVELS OF ^{27}Al WITH EXCITATION ENERGIES 10.248, 10.586, AND 10.692 MeV FROM THE REACTION ^{26}Mg(p,γ)^{27}Al. Koval, A. A.; Kopanets, E. G.; Korda, Yu. S.; Sukhotin, L. N.; Tsytko, S. P. Yadern. Fiz., 5: 1156-60(June 1967). (In Russian).

The decay schemes of resonance levels from the reaction ^{26}Mg(p,γ)^{27}Al at E_p = 2,052, 2,403, and 2,513 keV were investigated. Double and triple γ angular correlations were studied in order to estimate the spins of the resonance levels in ^{27}Al. The evaluation of the results according to the χ^2 criterium makes it possible to indicate the spins of the resonance levels of ^{27}Al and quadrupole-dipole mixture coefficients for some γ transitions. (auth)

33940 γ-SPECTRA FROM (n,γ) REACTION INDUCED BY THERMAL NEUTRONS ON ISOTOPES ^{58,60,62}Ni. Bogdanov, A. P.; Bystrov, L. N.; Rudak, E. A.; Firsov, E. I. (Inst. of Physics, Minsk). Yadern. Fiz., 5: 1161-9(June 1967). (In Russian).

The γ-spectrum from the (n,γ) reaction induced by thermal neutrons on ^{58}Ni, ^{60}Ni, and ^{62}Ni was investigated with the Belorussian Academy of Sciences reactor using the magnetic Compton γ spectrometer with a resolution of 2% and a luminescent two-crystal coincidence spectrometer. The scheme is proposed for γ transitions from the capture states of ^{59}Ni, ^{61}Ni, and ^{63}Ni. (auth)

33941 ENERGY AND ANGULAR DISTRIBUTIONS OF PHOTOPROTONS FROM THE NUCLEUS ^{40}Ca. Dragnev, T. N.; Komar, A. P. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 5: 1170-4(June 1967). (In Russian).

The angular and energy distributions of photoprotons from the metallic calcium of natural isotopic content irradiated by bremsstrahlung spectra with $E_{\gamma max}$ = 16 and 19 MeV were measured. The energy distributions are shown to have bumps due to a discrete level structure of the excited nucleus ^{40}Ca. The angular distributions of protons with energies near the bumps are practically isotropic. The comparison of the obtained results with those of other experiments and with calculations is made. (auth)

33942 CROSS SECTIONS OF (n,p) AND (n,α) REACTIONS ON Cu, Zn, Ga, AND Ge ISOTOPES WITH 14.8-MeV NEUTRONS. Vinitskaya, G. P.; Levkovskii, V. N.; Sokol'skii, V. V.; Kazachevskii, I. V. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 5: 1175-8(June 1967). (In Russian).

Absolute cross-sections for (n,p) and (n,α) reactions on Cu, Zn, Ga, and Ge isotopes were measured using the activation method. (auth)

33943 DIFFRACTION SCATTERING OF 40-MeV α PARTICLES BY COMPLEX NUCLEI. Gonchar, V. Yu.; Zheltonog, K. S.; Ivanov, G. N.; Kanashevich, V. I.; Laptev, S. V.; Yushkov, A. V. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 5: 1179-85(June 1967). (In Russian).

The diffraction scattering of 40-MeV α particles on the nuclei ^{24}Mg, ^{28}Si, ^{58}Ni, and Ge was studied. The experimental data on elastic and inelastic scattering were analyzed for the nuclei studied as well as for some neighbor nuclei with the explicit expressions for $\sigma(\theta)$ obtained by Inopin by means of complex angular momenta. Radii and diffusion ranges of light and intermediate nuclei are compared as obtained from the α-scattering and fast electron scattering on nuclei. (auth)

33944 POLARIZATION OF PROTONS DURING ELASTIC SCATTERING ON CALCIUM. Prokopenko, V. S.; Pucherov, N. N.; Rudyk, A. F. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 523-5(Mar. 1967). (In Russian).

The method of double scattering was used to investigate the polarization of 6.8-MeV protons after elastic proton scattering on a calcium target of 200-keV thickness. The scattered proton beam then struck a carbon analyzing target (distance between targets of 162 mm). The doubly scattered protons were counted with two scintillation telescopes situated at an angle of 45° to the axis of the analyzing carbon target. The solid angle seen by each telescope was 0.004 stere. The polarization was calculated from the data. A large negative polarization was observed at scattering angles of about 70°. This large minimum at relatively small scattering angles was unexpected at proton energies of 6.8 MeV. (TTT)

33945 EXCITATION FUNCTION OF THE ^{27}Al(p,γ)^{28}Si REACTION IN THE ENERGY INTERVAL OF Ep = 2300 TO 3200 keV. Koval, A. A.; Kopanets, E. G.; Korda, Yu. S.; Sukhotin, L. N.; Tsytko, S. P. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 12: 518-21(Mar. 1967). (In Russian).

An attempt was made to automatize the taking of physical measurements. The gamma ray yield was determined three times for each proton energy. The average of the three measured values was computed, together with the average square error. If the error was greater than a certain preselected value (in this case $5\sqrt{n}$, where n is the number of readings), the whole process was repeated again for the same proton energy. The proton energy was changed in steps of 2 keV. Before proceeding to the next measurement, the derivative was calculated in order to determine the nearness of a resonance. If the derivative was greater than a certain value, the proton energy step was decreased by a factor of two (1 keV). A plot of the gamma yield as a function of proton energy was plotted out automatically by the control machine "Dnieper." The position of 50 resonances and the excitation energies of ^{28}Si nuclear levels are also tabulated for various proton energies of the ^{27}Al(p,γ)^{28}Si reaction. (TTT)

33946 APPLICATION OF THE OPTICAL MODEL FOR DESCRIPTION OF INTRANUCLEAR EFFECTS. Chesnokova, V. D. (Kiev State Univ.). Ukr. Fiz. Zh., 12: 368-74(Mar. 1967). (In Russian).

The flux and its divergence are calculated for neutrons with 7-MeV energy in a ^{208}Pb nucleus and for neutrons with energies of 5, 10, and 20 MeV in a ^{40}Ca nucleus. When calculating the wave functions, a nonlocal potential with surface absorption was used. The behavior of the flux depending on the energy of the impinging particles was studied with fixed parameters of the nonlocal potential. (auth)

33947 ANALYSIS OF DIFFERENTIAL CROSS SECTIONS OF THE REACTION ^{27}Al(α,t)^{28}Si BASED ON APPROXIMATION OF DISTORTED WAVES. Nemets, O. F.; Rudchik, A. T. Ukr. Fiz. Zh., 12: 390-3(Mar. 1967). (In Russian).

The results are presented of investigations of differential cross sections of the reaction ^{27}Al(α,t)^{28}Si at 27.2 MeV in which stripping theory was used proceeding from the distorted-wave approximation. The possibility of the effective application of the (α,t) reaction to nuclear spectroscopy is studied. (D.C.W.)

33948 DOUBLE-PHOTON DECAY IN ^{90}Zr AND DOUBLE INTERNAL BREMSSTRAHLUNG IN THE BETA DECAY OF ^{90}Y AND ^{32}P. Vanderleeden, Johannes Cornelis. Columbus, Ohio, Ohio State Univ., 1966. 169p.

Thesis.

The unique form of the matrix element for double-photon decay (DPD) proceeding from an excited nuclear state may give information, not otherwise obtainable, regarding the correlation between protons in the nucleus and the lifetime of states in the giant dipole resonance. Accordingly, a search was made for two-photon emission in the de-excitation of the 1.76 MeV 0^+ first excited state in ^{90}Zr. This state is weakly populated (0.023%) in the β decay of ^{90}Y, the β decay to the 0^+ ^{90}Zr ground state (99.98%) being strongly favored. The time-coincidence of the DPD photons is used to discriminate against the intense single internal bremsstrahlung. A "fast-slow" coincidence spectrometer was modified to suppress higher-order accidental coincidences, to make possible the accumulation of prompt and accidental coincidences simultaneously and to permit two-dimensional pulse-height analysis. Data were taken at 90° (600 hr) and 180° (324 hr). The resulting net coincidence spectra show neither the energy distribution nor the angular correlation expected for the $0^+ - 0^+$ two-photon spectrum. The observed coincidence spectra are continuous, and appear to have an

endpoint at 2.26 MeV; in addition, there is evidence of a weak, higher-energy tail. It is concluded that the coincidence distributions are not primarily the result of the expected two-photon decay, and a least-squares fit of the data with the theoretical two-photon spectrum gives the following upper limit for the decay probability: $W_{\gamma\gamma}/W_{pair} + W_e) < 8 \times 10^{-5}$, where $W_{\gamma\gamma}$, W_{pair}, and W_e are the probability for de-excitation of the 0^+ state by two-photon emission, pair production, and electron conversion, respectively. This upper limit is considerably smaller than recent theoretical estimates. It is concluded that the matrix element for DPD is extremely sensitive to correlations between protons, and that the 0^+ excited state in ^{90}Zr may have to be described as a mixture of a Hartree–Fock ground state and a deformed collective state. Careful analysis showed that the observed coincidence spectra are source-originating and not the result of any instrumental effect, such as counter-to-counter Compton scattering, or a source impurity. The process of double internal bremsstrahlung (DIB) was then considered as a possible explanation. In this process, two photons are created in the same β-decay, in contrast to the well-known process of single internal bremsstrahlung (IB) where one photon is produced. Mulligan and Seyler have calculated the probability for DIB originating in the intense ^{90}Y 2.26-MeV ground-state β transition. The observed coincidence spectra agree with their calculations for double internal bremsstrahlung in magnitude, in energy dependence, and in the angular correlation of the two gamma rays. Additional coincidence spectra were recorded with two ^{32}P sources. ^{32}P is a pure β-emitter with an endpoint energy of 1.71 MeV; it is expected to produce DIB comparable in intensity to ^{90}Y. The experimental results agree in order-of-magnitude with Mulligan and Seyler's calculations for DIB in ^{32}P, the comparison in this case being somewhat impaired by the subsequently verified presence of a radioactive impurity in the ^{32}P sources. (Disser. Abstr.)

33949 NUCLEAR STRUCTURE STUDIES IN THE ZINC AND SELENIUM ISOTOPES WITH (d,p) AND (d,t) REACTIONS. **Lin, Ernest Erh-kang. Pittsburgh, Univ. of Pittsburgh, 1965. 134p.**

Thesis.

Levels of ^{65}Zn, ^{67}Zn, ^{69}Zn, ^{69}Zn, ^{77}Se, ^{79}Se, ^{79}Se, ^{81}Se, and ^{83}Se below 5 MeV were investigated by observation of the energy and angular distributions of protons emitted in the (d,p) reactions at 15 MeV bombarding energy. Values of the transferred neutron angular momenta and of the spectroscopic factors for levels were derived from the measurements by DWBA calculations. Sum rules are applied to estimate the degree of filling of shell-model states. The results for this and locations of the "centers of gravity" of the shell-model levels are compared with results for isotonic nuclei, and with the pairing theory of Kisslinger and Sorensen. In the Se isotopes, $3/2^-$, $5/2^-$, $1/2^-$, and $9/2^+$ neutron subshells in the 28–50 neutron shell were found to be filling in these isotopes, but the $3/2^-$, $5/2^-$ and $1/2^-$ subshells are less full and the $g_{9/2}$ more full than expected. It was found for the selenium nuclei that general agreement with pairing theory can be obtained with the following parameters: $\epsilon_{g_{9/2}} = 3.0$ MeV, $\epsilon_{p_{3/2}} = 2.5$ MeV, $\epsilon_{p_{1/2}} = 1.0$ MeV, $\epsilon_{f_{5/2}} = 0$ and $\Delta = 1.65$ MeV; this differs from Kisslinger and Sorensen parameters: $\epsilon_{g_{9/2}} = 3.76$ MeV, $\epsilon_{p_{3/2}} = 2.51$ MeV, $\epsilon_{p_{1/2}} = -0.18$ MeV, $\epsilon_{f_{5/2}} = 0.09$ MeV and $\Delta = 1.10$ MeV. The results for zinc nuclei, because of insufficient experimental energy resolutions, fall far short of giving quantitative consistence with pairing theory. In ^{83}Se, an isomer of spin $1/2^-$ at 0.22 MeV was identified by analogy with isotonic nuclei. Measurements on (d,t) reactions are also included; among other things, they indicate that for Zn nuclei, the 39th and 40th neutrons go predominately into $g_{9/2}$ rather than $p_{3/2}$ states; for Se nuclei the $d_{5/2}$ subshell in the next (50–82) major shell is filling even though the lower (28–50) major shell is not completely full. The collective behaviors of even–even nuclei of Zn and Se isotopes at low energies were also investigated by the inelastic deuteron scattering. The 4^+ state of the two-phonon triplet and the collective 3^- state in ^{82}Se were identified by energy and cross section systematics. (Disser. Abstr.)

33950 EXCITED NUCLEAR STATES OF SULFUR AND ARGON PRODUCED BY 3 TO 4 MeV ALPHA PARTICLES. **Carlton, Patrick Nelson. Gainesville, Fla., Univ. of Florida, 1966. 72p.**

Thesis.

Radiative alpha capture was studied in silicon and sulfur. The relative ease of assigning spins and parities through (α,γ) spectroscopy of "even–even" nuclei has been pointed out. The University of Florida 4 MeV Van de Graaff accelerator was used to produce singly ionized ^{4}He in the 3 to 4 MeV range at 2 microamperes average currents. Targets of SiO_2, both natural and ^{28}Si-enriched (>98%), natural ZnS, and ^{32}S-enriched (>98%) elemental sulfur were evaporated onto 0.004 in. thick copper backings. With natural silicon targets, eight resonances were found between 3.22 and 3.78 MeV bombarding energy; the 3.51, 3.65, and 3.76 MeV resonances have 1^-, 1^-, and 2^+ spins and parities, respectively. Using ^{28}Si-enriched targets, the first seven levels were not found, indicating that they were due to the ^{30}Si component in natural silicon, producing levels in ^{34}S. Resonances were found at 2.88, 2.90, 3.16, 3.76, 3.84, 3.89, 3.96, and 4.01 MeV in enriched ^{28}Si, corresponding to ^{32}S excitation energies of 9.47, 9.48, 9.71, 10.23 (2^+), 10.31, 10.35 (1^-), 10.41, and 10.45 (2^+) MeV, respectively, where the spin and parity of the levels is indicated in parentheses when found. In the region $3.10 < E_\alpha < 3.60$ MeV, eight resonances were found using natural sulfur targets; seven of these correspond to previously reported levels in ^{38}Ar and the 9.47 MeV level has been reported as due to the $^{32}S(\alpha,\gamma)^{36}$Ar reaction. Sulfur 32-enriched targets were investigated over the alpha particle bombarding energy range of 3.14 to 4.13 MeV with fourteen resonances observed. These resonances represent excitation energies of 9.45 to 10.30 MeV in argon 36. Spins and parities, where assigned, were determined from angular distributions of the gamma rays taken at the resonances. It is noted that for self-conjugate nuclei in the mass region investigated, the isobaric spin selection rule is effective for E1 transitions. (Disser. Abstr.)

33951 INELASTIC ELECTRON SCATTERING FROM THE EVEN NICKEL ISOTOPES. **Duguay, Michel Albert. New Haven, Yale Univ., 1966. 154p.**

Thesis.

Electron beams produced by the Yale linear electron accelerator at energies varying from 45 to 65 MeV were scattered from the nuclei ^{58}Ni, ^{60}Ni, ^{62}Ni. Inelastic energy spectra were measured at angles ranging from 70° to 150°; the corresponding momentum transfer range covered, was from 0.25 F^{-1} to 0.53 F^{-1}. Form factor measurements are presented for the first excited state in each of the three isotopes, the anomalous octupole state in ^{58}Ni and ^{60}Ni (at 4.48 and 4.038 MeV respectively), and for the 3.035 and 3.260 MeV states of ^{58}Ni. The data were analyzed using a distorted partial-wave calculation. The reduced transition probabilities $B(E2,0^+ \rightarrow 2^+)$ obtained for the first excited (quadrupole) state of the three isotopes were found to be in excellent agreement (±15%) with earlier Coulomb excitation measurements, providing a good check on the distorted wave calculation. The values for the reduced transition probabilities obtained for the ^{58}Ni and ^{60}Ni octupole states were 16×10^3 e^3f^6 ± 30% and 27×10^3 e^2f^6 ± 30% respectively. Transition radii were extracted from the form factor measurements for all transitions quoted above, and were compared to similar measurements in the lighter elements. (Disser. Abstr.)

33952 BETA–GAMMA–GAMMA CORRELATION IN ^{56}Mn: A TEST OF TIME REVERSAL INVARIANCE. **Garrell, Martin Henry. Urbana, Ill., Univ. of Illinois, 1966. 82p.**

Thesis.

An experiment to measure time reversal violation in two β-γ-γ cascades of ^{56}Mn (2.58 hr) is discussed. It is shown how one measures the interference terms in β-γ-γ correlations using experimental quantities. The systematic errors involved in an accurate correlation experiment are explained in detail, and the inherent limitations of such an experiment for time reversal measurements are pointed out. Particular attention is given to descriptions of the electronics system used. From measurements of the interference terms in two γ transitions of ^{56}Mn, it is concluded that the phase difference between M1 and E2 reduced matrix elements is $3.3 \pm 3.0 \times 10^{-2}$ and $-4.3 \pm 4.0 \times 10^{-2}$ for the 1.81- and 2.12-MeV transitions, respectively. (Disser. Abstr.)

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Refer also to abstracts 32466, 33872, 33924, 33932, 33946, 33948, 34037, 34041, 34042, 34055, 34062, and 34078.

33953 (AAEC/E–168) A STUDY OF THE EFFECTIVE RESONANCE INTEGRAL AND DOPPLER COEFFICIENT OF ^{238}U, ^{232}Th, AND ^{240}Pu USING THE CODE COMPLEX LUBRA. **Keane, A.; Kletzmayr, E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec. 1966. 34p. Dep.**

The effective resonance integral and Doppler coefficient of ^{238}U, ^{232}Th, and ^{240}Pu were studied in detail using the LUBRA complex of codes. Some earlier results were used for comparison to verify the validity of the LUBRA results. Discrepancies were explained, and confidence can be placed in the results given by the LUBRA codes. (auth)

33954 (AECL–2687) PHYSICS DIVISION PROGRESS REPORT, JANUARY 1–MARCH 31, 1967. **(Atomic Energy of Canada Ltd., Chalk River (Ontario)). 69p. (PR-P–73). Dep. CFSTI. CAN $1.50.**

BISMUTH, LEAD—proton reactions at 1 GeV, cascade neutron angular distributions and spectra from (T)
MAGNESIUM-25—energy levels from proton inelastic scattering, lifetimes and branching ratios for (E)
GAMMA RADIATION—angular correlations from aligned nuclei, computer program for least squares analysis of
NUCLEI—gamma angular correlations from aligned, computer program for least squares analysis of
SILICON-29—energy levels from proton inelastic scattering, spin assignments from γ-γ angular correlations (E)
PROTONS—scattering by silicon-29, γ-γ angular correlations from inelastic (E)
COSMIC RADIATION—intensity variations with latitude (E); intensity variations during solar cycle, diurnal (E)
EUROPIUM-152—decay of, γ-γ coincidence spectra from (E)
GADOLINIUM-152—energy-level spins and transitions from europium-152 beta decay (E)
SAMARIUM-152—energy-level spins and transitions from europium-152 electron-capture decay (E); energy levels from decay of isomeric europium-152, β-vibrational (E)
THULIUM-169—nuclear magnetic fields in iron (E)
IRON—thulium-169 nuclear magnetic fields in (E)
PRASEODYMIUM-141—energy-level transitions in, multipolarity of 145.4-keV (E)
HOLMIUM-166, PRASEODYMIUM-144, BISMUTH-210, BISMUTH-212—energy-level transitions in, L-subshell intensity ratios for M1 (E)
SILVER-110—activity standards for isomeric
RADIATION DETECTORS, PROPORTIONAL—development of gas-flow, with beryllium and mylar side windows
GAMMA SPECTROMETERS—development of triple coincidence, using lithium-drifted germanium detectors
RADIATION DETECTORS, SEMICONDUCTOR (GERMANIUM)—performance of lithium-drifted, temperature dependence of
GAMMA RADIATION—polarization of, system for measuring
POLARISCOPES—development using sodium-iodide detectors, for gamma radiation
MAGNETITES—spin-wave spectra below electron ordering temperature (E)
MOLYBDENUM ALLOYS, NIOBIUM ALLOYS—Mo–Nb, phonon dispersion relations for (E)
HOLMIUM—neutron paramagnetic scattering by powders and single crystals of
NEUTRONS—scattering by holmium powders and single crystals, paramagnetic (E)
ERBIUM—neutron paramagnetic scattering by powders of (E)
HELIUM—neutron scattering at 1.1°K, time-of-flight spectra from (E)
POTASSIUM BROMIDES—phonon velocity in, temperature dependence of (E)
LINEAR ACCELERATORS—electromagnetic fields in, methods for calculating
ELECTROMAGNETIC FIELDS—distributions in linear accelerators, methods for calculating
NUCLEONS—scattering amplitudes for, three-body (T)
FISSION PRODUCTS—dispersion in reactor cooling systems
REACTORS—cooling systems of, fission-product dispersion in (D.C.W.)

33955 (AERE-R-5488) CALCULATED INDEPENDENT YIELDS IN THERMAL FISSION OF ^{235}U, ^{239}Pu, ^{241}Pu, AND ^{233}U. Crouch, E. A. C. (Atomic Energy Research Establishment, Harwell (England)). May 1967. 16p. Dep. CFSTI. UK 2s. 6d.

The independent yields of fission products are calculated for the thermal fission of ^{233}U, ^{235}U, ^{239}Pu, and ^{241}Pu by the method of Wahl et al. [Phys. Rev. 126: 1112 (1962)]. Results are tabulated. (auth)

33956 (AI-67-93) TUNGSTEN RESONANCE INTEGRALS AND DOPPLER COEFFICIENTS. Final Report. Royden, H. N.; Paschall, R. K.; Otter, J. M.; Carpenter, S. G. (Atomics International, Canoga Park, Calif.). June 30, 1967. Contract NAS3-7982. 84p. (NASA-CR-72229).

Measurements of effective resonance integrals and Doppler coefficients of thick samples of natural and enriched tungsten were performed in a 1/E spectrum with sample temperature up to 2273°K and compared with calculated values. Results of the Doppler measurements up to 1370°K clearly favor the $T^{\frac{1}{2}}$ dependence of resonance absorption usually assumed for a 1/E spectrum, where T is the absolute temperature of the absorber. Measurements from 1370 to 2273°K were made with ovens of a new design, and were less accurate because of large oven-dependent reactivity effects. The epicadmium reactivity of each sample was determined as a function of temperature in the Sodium Graphite Reactor Critical Assembly (SGR-CA). These reactivities were converted into effective resonance integrals by comparison with epicadmium measurements on samples of gold, which has a well-known effective resonance integral. Reactivities were determined from the reactor power history during repeated cycles of sample insertion and removal, by numerical solution of the reactor-kinetic equations. For Doppler-effect measurements, tungsten samples were heated electrically in evacuated ovens. Calculations were carried out with a resonance-integral code based on analytical approximations to the neutron slowing-down equation and an improved rational approximation to the escape probability for lumped absorbers. This method overestimated both effective resonance integrals and Doppler coefficients by as much as 25% for some samples. Resonance overlap in natural tungsten and failure of the flat-source approximation in ^{186}W can account for most of the resonance-integral overestimates for these two samples. Reasons for the other discrepancies are being investigated; it seems likely that no single effect is responsible. (auth)

33957 (AWRE-O-43/67) PROMPT NEUTRON EMISSION FROM ^{235}U FISSION FRAGMENTS. Maslin, E. E.; Rodgers, A. L.; Core, W. G. F. (Atomic Weapons Research Establishment, Aldermaston (England)). June 1967. 35p. Dep. CFSTI. UK 5s. 0d.

A description is given of measurements of the prompt neutron emission from fission fragments of ^{235}U in thermal-neutron-induced fission. A beam of neutrons from the AWRE research reactor HERALD induces fissions in a thin (20 μg/cm^2) sample of ^{235}U. Neutrons are detected in a large (250 litres) liquid scintillation counter, and the fragment kinetic energies are measured with gold-silicon surface-barrier counters. Distributions showing the neutron emission from both individual fission fragments and from pairs of fragments are given as functions of both the mass of the fragment and the total kinetic energy of the pair. (auth)

33958 (BNL-325(2nd Ed.)(Suppl.2)(Vol.2C)) NEUTRON CROSS SECTIONS. VOLUME IIC. Z equals 61 TO 87. Goldberg, Murrey D.; Mughabghab, Said F.; Purohit, Surendra N.; Magurno, Benjamin A.; May, Victoria A. (Brookhaven National Lab., Upton, N. Y.). Aug. 1966. 439p. Dep. CFSTI.

An updated compilation of neutron cross sections and resonance parameters is presented for Z = 61 to 87 nuclei. The reference sources for the data are also listed. (D.C.W.)

33959 (COO-1112-109) THE ^{208}Pb(d,t)^{207}Pb REACTION WITH 15 TO 25 MeV DEUTERONS. Muehllehner, Gerd (Michigan Univ., Ann Arbor). 1966. Contract AT(11-1)-1112. 72p. Dep. CFSTI.

Thesis.

Differential cross sections for the reaction ^{208}Pb(d,t)^{207}Pb to single-particle levels in ^{207}Pb were measured for incident deuterons of 25 to 25 MeV. Differential cross sections for deuteron elastic scattering by ^{208}Pb were also measured in the same energy range. DWBA calculations were performed for several values of the bound neutron parameters and of the triton wave parameters using different forms of the interaction. (D.C.W.)

33960 (IS-1567) PRELIMINARY STUDIES OF DELAYED NEUTRON EMISSION FROM SEPARATED ISOTOPES OF GASEOUS FISSION PRODUCTS. Day, G. M.; Tucker, A. B.; Talbert, W. L. Jr. (Ames Lab., Iowa). May 1967. Contract W-7405-eng-82. 25p. (CONF-670424-1). Dep. CFSTI.

From IAEA Panel Meeting on Delayed Neutrons, Vienna, Austria.

An on-line isotope separator system is described, which was designed for use in studies of short-lived activities produced at a reactor. Detailed description is presented for the use of this system in the study of radioactive decay and delayed neutron emission for gaseous fission products formed in the fission of ^{235}U. Experiences with sample configuration and characteristic limitations of the system (such as half-life) are discussed. Preliminary results are presented regarding the assignment of delayed-neutron precursors to mass number (by neutron counting) and element (by half-life determination). At present, definite assignments were made for ^{91}Kr, ^{92}Kr, ^{93}Rb, and ^{93}Kr. Indications of delayed-neutron emission for masses 141 and 142 are discussed. Future plans for delayed-neutron studies are discussed and nuclear structure studies in progress are outlined. (auth)

33961 (JINR-E6-3386) SOME DECAY PROPERTIES OF ^{251}Fm AND ^{252}Fm. Khvashchevska, I.; Gavrilov, K. A.; Kush, V.; Shimchak, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 9p. Dep.

The alpha spectra of ^{251}Fm and ^{252}Fm and the α-γ spectrum of ^{251}Fm were investigated. The half-life of ^{252}Fm was determined to be 23.0 hr. The spectrum of ^{252}Fm shows a second alpha group 41 keV lower in energy and 15% in abundance. The α-γ coincidences revealed the 410 ± 10-keV gamma line de-exciting the level populated by the main ^{251}Fm α-particle group of 6.83 MeV in energy. (auth)

33962 (KAPL-P-3342) THE TEMPERATURE DEPENDENCE OF EPITHERMAL FISSION IN $^{235}UO_2$ RODS. Schoenig, F. C. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). June 10, 1967. Contract W-31-109-eng-52. 11p. (CONF-670602-21). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

The temperature dependence of resonance neutron fission in $^{235}UO_2$ was measured to 1525°C using UO_2 rods enriched to 93% in ^{235}U. Rods fabricated from cylindrical $^{235}UO_2$ pellets were irradiated in a Cd-covered, inert-gas-filled furnace, and the ^{140}La fission-product activities induced in the sample were measured at different temperatures. Normalized to the activities of Au wires that were placed about the exterior of the furnace, the activities represent a measure of the epithermal neutron fission. (D.C.W.)

33963 (NP-16498) ANNUAL REPORT, APRIL 1965–MARCH 1966. (Tokyo Univ. (Japan). Inst. for Nuclear Study). 108p. Dep. mn.

PALLADIUM-102, CADMIUM-106, CADMIUM-108, MERCURY-196, XENON-126, CERIUM-138, OSMIUM-186—energy level transitions in, anisotropy of conversion electrons from
RHENIUM-187—proton reactions (p,2n) at 14.3 MeV, anisotropy of conversion electrons from rotational levels in osmium-186 populated by
RHODIUM-103—proton reactions (p,2n) at 14.3 MeV, anisotropy of conversion electrons from vibrational levels in palladium-102 populated by
SILVER-107—proton reactions (p,2n) at 14.3 MeV, anisotropy of conversion electrons from vibrational levels in cadmium-106 populated by
SILVER-109—proton reactions (p,2n) at 14.3 MeV, anisotropy of conversion electrons from vibrational levels in cadmium-108 populated by
GOLD-197—proton reactions (p,2n) at 14.3 MeV, anisotropy of conversion electrons from vibrational levels in mercury-196 populated by
IODINE-127—proton reactions (p,2n) at 14.3 MeV, anisotropy of conversion electrons from vibrational levels in xenon-126 populated by
LANTHANIUM-139—proton reactions (p,2n) at 14.3 MeV, anisotropy of conversion electrons from vibrational levels in cerium-138 populated by
TIN-116—helium-3 reactions (He-3,d) at 28.23 MeV, differential cross sections for
TIN-118—helium-3 reactions (He-3,d) at 28.3 MeV, antimony-119 energy levels from
ANTIMONY-119—energy levels from tin-118(He-3,d) reactions at 28.3 MeV
NICKEL-58—helium-3 reactions at 24.7 MeV, energy spectrum of particles from
NICKEL-58—helium-3 reactions (He-3,α) at 21.2 MeV, momentum spectrum of alpha particles from
YTTRIUM-89, ZIRCONIUM-90, ZIRCONIUM-92, CADMIUM-111, CADMIUM-112, TIN-116, TIN-120—proton elastic and inelastic scattering at 14.5 MeV, optical-model and DWBA analysis of
BERYLLIUM-9, CARBON-12—alpha reactions (α,2α) at 32.2 and 37.4 MeV, differential cross sections for
OXYGEN-16, ALUMINUM-27—helium-3 reactions at 10 to 30 MeV, beryllium-7 production by
NITROGEN-14—energy levels from proton elastic and inelastic scattering at 15.3 MeV.
MOLYBDENUM-96—energy levels from beta decay of niobium-96 and technetium-96
NIOBIUM-96—beta decay of, molybdenum-96 energy levels from
TECHNETIUM-96—beta and electron-capture decay of, molybdenum-96 energy levels from
LITHIUM ISOTOPES, TELLURIUM ISOTOPES, SELENIUM ISOTOPES—separation of
NICKEL—proton scattering at 14.6 MeV, momentum spectrum from
MASS SPECTROMETERS—design and operation of
SYNCHROTRONS—design and operation at Tokyo University
PHOTONS—interactions $\gamma + p \rightarrow p + \pi^0$ at 450 to 760 MeV, polarization of recoil protons in
PHOTONS—interactions $\gamma + p \rightarrow p + \pi^0 + \pi^0$ at 450 to 760 MeV, differential cross sections for
PHOTONS—interactions $\gamma + p \rightarrow \pi^- + \pi^+ + p$, yield measurements for
X RADIATION—absorption spectra for various metals and salts
ALUMINUM—X-ray absorption spectrum at 50 to 250 Å
BISMUTH—X-ray absorption spectrum at 50 to 200 Å
ANTIMONY—X-ray absorption spectrum at 50 to 250 Å
ALUMINUM ALLOYS, MAGNESIUM ALLOYS—Al–Mg, x-ray absorption spectrum at 50 to 250 Å
POTASSIUM CHLORIDES, SODIUM CHLORIDES—X-ray absorption spectrum at 50 to 62 Å
BREMSSTRAHLUNG—production of polarized
LEAD, COPPER, ALUMINUM—electron reactions at 600 MeV, energy losses in cascade showers produced by
COSMIC SHOWERS—analysis and observation of, design of equipment for
ALUMINUM-26—detection of muon-induced, in nature
PRASEODYMIUM-141—proton reactions (p,n) and (p,2n) at 6 to 15 MeV, cross sections for (S.F.L.)

33964 (NP-16748) SOME NUCLEAR REACTIONS INDUCED BY D + T NEUTRONS. Nagel, Walter (Amsterdam Univ. (Netherlands)). 1966. 87p. Dep.

Thesis.

A report is given on the study of some nuclear reactions induced by neutrons, produced by means of the reaction t(d,n)α, so called D + T neutrons. A general description is given of the reactions which are possible with high energy neutrons. Because of existing confusion in cross section terminology a section is inserted in which the definitions of terms used in this thesis are described. A historical survey of the development of work with D + T neutrons is presented. Methods by means of which cross sections can be determined are discussed. Results were obtained by the activation method and therefore the discussion is limited to methods which can produce results which are comparable with those presented. The production of D + T neutrons and reasons why the neutrons are not mono-energetic are discussed. The energy spread is discussed for the neutrons which are emitted by the two devices employed in the investigation. The methods available for the determination of the number of neutrons emitted are described. After a brief survey of the primary methods (α-counting and proton recoil counting) the consistency of these methods is discussed. The major part, however, is devoted to nuclear reactions which can be used as standards. The most likely shape of the excitation function is deduced for each of the reactions mainly used. With the published data on absolute cross sections, the absolute values were derived for these functions. (S.F.L.)

33965 (NP-16835) AN ALPHA–GAMMA CORRELATION SPECTROMETER USING SURFACE BARRIER ALPHA DETECTORS. APPLICATION TO THE MEASUREMENT OF ANGULAR CORRELATIONS IN THE DECAY OF ^{212}Bi TO ^{208}Tl. Klein, Siebren Sake (Vrije Universiteit, Amsterdam (Netherlands)). [1966]. 112p. Dep.

Thesis.

Methods of alpha spectrometry are compared, and the theory of nuclei in the region of ^{208}Pb is reviewed with emphasis on the alpha decay and shell-model description of these nuclei. An experiment is then discussed in which $\alpha - \gamma$ angular correlations in the decay of ^{212}Bi were measured using surface-barrier detectors for the alpha particles and an NaI(Tl) crystal for the gamma rays. The experimental arrangement is described in detail, including the corrections that were made. Alpha and gamma spectra are presented together with the angular-correlation data. Spin assignments, transition multipolarities, and transition matrix elements for levels in ^{208}Tl are discussed in view of theoretical predictions. (D.C.W.)

33966 (PAEC(A)IN-661) REACTOR CROSS SECTIONS. A Literature Search. (Philippine Atomic Energy Commission, Manila). Nov. 1966. 131p. Dep.

A bibliography of 805 entries is presented on nuclear reaction cross sections. The references cited were abstracted in Nuclear Science Abstracts during the period September 8, 1948, to October 1965. (S.F.L.)

33967 (UCRL-17472) NUCLEAR SPIN AND HYPERFINE STRUCTURE MEASUREMENTS ON THE RADIOACTIVE ISOTOPES ^{110}In, ^{121}Sn, AND ^{88}Rb. Prior, Michael Herbert (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 25, 1967. Contract W-7405-eng-48. 96p. Dep. CFSTI.

Thesis.

The atomic-beam magnetic-resonance technique was used to measure the nuclear spin of 66-min ^{110}In, the spin and hyperfine structure interaction constants a and b for 27-hr ^{121}Sn in the $^3P_1$ electronic state, and the a constant for 18-min ^{88}Rb (I = 2). Values of the nuclear moments are inferred from the measured interaction constants. The χ^2 of the least-squares computer fit to the observations is listed for the two possible signs of the interaction constants. The figures in parentheses represent the error in the last figure quoted. For the hfs constants this is one standard deviation from the computer mean. For μ_I the error is 1% to allow for effects of a possible hyperfine structure anomaly. For Q the error is 50% to allow for inaccuracies in the calculation of $\langle r^{-3} \rangle$ and the effects of Sternheimer shielding. A relativistic calculation accounts for ≈½ of the a for ^{121}Sn, and the remainder is attributed

to the effects of configuration interaction. Second-order corrections to the hfs constants are shown to be negligible for ^{121}Sn. The nuclear quantities, except for Q, are in reasonable agreement with values calculated by using the shell model with an appropriate residual interaction, provided one takes the negative sign for the interaction constants. The quadrupole moment of ^{121}Sn may arise from polarization of the proton core. (auth)

33968 (WAPD-TM-622) MEASUREMENT OF THE EFFECTIVE RESONANCE INTEGRAL OF 30-MIL THORIUM WIRE RELATIVE TO THE INTEGRAL AT INFINITE DILUTION. Rothman, A. B.; Connor, J. C.; Conway, D. E. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Mar. 1967. Contract AT(11-1)-Gen-14. 15p. Dep. CFSTI.

The effective neutron-capture resonance integral I of 30-mil-diameter thorium wire (surface-to-mass ratio, S/M, of 4.65 cm^2/g) was measured relative to I_0, the integral at infinite dilution, by comparing the ratio of the gamma activities induced in wires irradiated bare and under cadmium with a similar ratio measured for very dilute thorium foils. The experimental result for I/I_0 is 0.425 ± 0.005 for an infinite-length wire in a 1/E spectrum relative to a low-energy cutoff of 0.5 eV. This result and the values reported by other investigators for heavily self-shielded and dilute thorium are least-squares fitted by an expansion in powers of the square root of S/M. (auth)

33969 (WAPD-TM-665) RESQ-2: A COMBINED ANALYTIC-MONTE CARLO CALCULATION OF RESONANCE ABSORPTION BASED ON SUPERPOSITION. Anderson, B. L.; Gelbard, E. M.; Spanier, J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1967. Contract AT(11-1)-Gen-14. 43p. Dep. CFSTI.

The program, RESQ-2, written in FORTRAN IV for the CDC-6600 for the calculation of resonance escape probabilities, is described. The fuel elements treated are assumed to be infinite cylindrical rods, with cladding, arranged in a regular hexagonal array. The resonance integral is represented as an integral in the narrow resonance approximation, plus correction terms. This decomposition makes it possible to apply Monte Carlo methods to the calculation in such a way that the efficiency is greatly enhanced when the resonance escape probability is close to one. (auth)

33970 (NP-tr-1555) FISSION YIELDS OF IODINE ISOTOPES 131 TO 135 IN THE SPONTANEOUS FISSION OF ^{238}U. Menke, H.; Herrmann, G. Translated by D. Verdin (Atomic Energy Research Establishment, Harwell, Eng.), from Radiochim. Acta, 6: 76-80(1966). 18p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Cumulative yields of the iodine isotopes 131 to 135 were determined radiochemically for the spontaneous fission of ^{238}U. Iodine isotopes were separated after various times of formation from two uranyl chloride solutions containing 936 or 3400 g of natural uranium and counted in an anticoincidence counter. The decay curves were analyzed by use of a computer. The following yields were obtained as weighted mean values of six experiments: ^{131}I(0.5 ± 0.3%), ^{132}I(3.2 ± 0.9%), ^{133}I(3.6 ± 1.0%), ^{134}I(7.2 ± 1.4%) and ^{135}I(4.5 ± 0.6%). At mass numbers 132 and 134 the yields lie above a smooth mass yield curve. (auth)

33971 DELAYED GAMMA RADIATION FROM FISSION FRAGMENTS FROM THE SLOW NEUTRON INDUCED FISSION OF ^{235}U. Popeko, L. A.; Val'skii, G. V.; Petrov, G. A.; Kaminker, D. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 2040-7 (Dec. 1966). (In Russian).

Delayed gamma radiation emitted by fission fragments from the slow-neutron-induced fission of ^{235}U was investigated. The target was a 2.3 cm diameter 400 $\mu g/cm^2$ thick film of uranium oxide on a 40 $\mu g/cm^2$ aluminum oxide substrate. The target was mounted between two n-p type gold-silicon semiconductor detectors, which served to record the two fission fragments, and was located in the neutron beam from a reactor. The direction of the neutron beam was parallel to the plane of the target. The gamma rays were detected by a 3 cm × 4 cm NaI(Tl) scintillator immediately beyond one of the fission fragment detectors. This scintillator recorded with good efficiency only gamma rays produced in its immediate vicinity, i.e., it recorded essentially only gamma rays emitted by a fragment after it had been brought to rest in the associated semiconductor detector. The minimum delay of the recorded gamma rays was thus determined by the fragment flight time from the target to the detector; this detector was mounted 10 cm from the target, and the minimum delay time was accordingly about 10^{-8} sec. The pulses from the semiconductor detectors and the scintillator were analyzed in a rather complex electronic circuit and were recorded in pulse height analyzers. The delayed gamma ray spectra from the heavier and the lighter fragments are presented graphically. The lighter fragment produced more delayed gamma rays per fission than did the heavier one. A peak was observed in each of these spectra that had not been found in the previous work of the authors (Atomnaya Energiya, 19: 186 (1965)). It is suggested (but it was not confirmed) that each of these peaks may be due to simultaneous recording of gamma rays belonging to two other peaks observed in both experiments. The gamma-ray spectrum was investigated as a function of the fragment mass. For this investigation the gamma-ray energy range was divided into three regions (above 40 keV, between 100 and 185 keV, and between 185 and 250 keV), the fission fragment masses were determined from the kinetic energies of the two fragments from the same fission, and the results are presented graphically. There are considerable differences between the curves for the different gamma-ray energy ranges and between the present curves and the analogous curves obtained by Sven A. E. Johansson [Nucl. Phys., 64: 147(1965)] for spontaneous fission of ^{252}Cf. No dependence of the delayed gamma-ray spectrum on the total mass of the two fragments could be detected. (ATD)

33972 THE SPECTRUM OF ^{184}Re CONVERSION ELECTRONS AT ENERGIES EXCEEDING 750 keV. Ageev, V. A.; Klimenko, A. S.; Maidanyuk, V. K.; Feoktistov, A. I. (Kiev State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 2037-9(Dec. 1966). (In Russian).

Energies and relative intensities of conversion electrons in the hard region of the ^{184}Re spectrum were measured using a source of natural tungsten irradiated by 13.6-MeV deuterons. The irradiated target was dissolved in 3% H_2O_2 with the basic part of W separated by precipitation as tungstic acid from 1N of the HCl solution. Measurements carried out 5 months later using a magnetic β-ray spectrometer with a resolving power of 0.2 to 0.3% are tabulated. The data obtained confirmed the presence of all the γ transitions recorded by B. S. Dzhelepov et al., [Izv. Akad. Nauk SSSR Ser. Fiz., 27: 1394 (1963)] and the presence of 1008.2- and 1018.9-keV transitions reported by B. Harmatz et al. [Nuc. Phys. 56: 1 (1964)]. However, the conversion lines at 980.3, 995.0, 1002.7, 1034.5, and 1180 keV were not found. According to the estimate, their intensity must be below 0.3 of the intensity of the K1011.1 line. A series of measurements was also made in the soft region of the ^{184}Re spectrum; the data obtained are tabulated and discussed. (R.V.J.)

33973 NEW SHORT-LIVED AMERICIUM BETA EMITTERS. Orth, C. J.; Daniels, W. R.; Erkkila, B. H.; Lawrence, F. O.; Hoffman, D. C. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Phys. Rev. Lett., 19: 128-31(July 17, 1967). (LA-DC-8843).

^{247}Am was chemically separated from the products of α-particle bombardment of ^{244}Pu. Gamma transitions of 226 and 285 keV are associated with its decay. The intensities of the K- and L-conversion electrons from the 226-keV transition are most consistent with M2 multipolarity. Evidence was found in the americium fraction from both ^{3}He- and α-particle bombardments of ^{244}Pu for 153-, 205-, and possibly 99- and 555-keV γ rays; and it is believed that these transitions follow β decay of a high-spin ^{246}Am isomer. (auth)

33974 INVESTIGATION OF ^{110m}Ag γ RADIATION. Kracikova, T. I. (Czech Technical Univ., Prague); Kracik, B. Czech. J. Phys., 17: 483-5(1967). (In Russian).

Gamma spectra of ^{110m}Ag were measured up to gamma energies of 1600 keV using two Ge(Li) detectors and 200- and 4096-channel analyzers. Sources were prepared by neutron irradiation of natural Ag and Ag enriched in ^{107}Ag. Twenty-nine lines were separated in the combined $^{108m+110m}$Ag gamma spectrum. The energies and relative intensities of the ^{110m}Ag gamma rays were determined. Five previously unreported transitions were observed in the gamma energy range from 400 to 1600 keV. Experimental and theoretical data on the internal conversion coefficients indicated that all the observed transitions are E1 or M1, with the exception of a 1561-keV transition which is E3 or M2. (R.V.J.)

33975 HIGH-ENERGY SPECTRA OF 12-YR ^{152}Eu. Larsen, J. S.; Skilbreid, O.; Vistisen, L. (Univ. of Copenhagen). Nucl. Phys., A100: 248-56(1967).

An electromagnetically separated source of ^{152}Eu (10^{-4} per cent ^{154}Eu impurity) was investigated in a six-gap, beta spectrometer and with a Ge(Li) detector. The log ft value of the beta transition ^{152}Eu(ground state) → ^{152}Gd(ground state) is given a lower limit; log ft > 16.8. Some new conversion lines and the corresponding gamma lines were measured. The following transition energies (in keV) and multipolarities were found: 1252, E2; 1459, E1; 1528, E1; 1606, (E2); 1645, E2; and 1765, E2. (auth)

33976 PARTIAL HALF LIVES OF ALPHA DECAY OF ^{151}Tb AND ^{149}Tb NUCLEI. Kormicki, J. (Inst. of Nuclear Physics, Krakow); Niewodniczanski, H.; Stachura, Z.; Zuber, K.; Budziak, A. Nucl. Phys., A100: 297-304(1967).

The alpha branching ratios $\lambda_\alpha/\lambda_{tot}$ were measured, and partial

half lives of alpha decay for ^{151}Tb and ^{149}Tb nuclei were determined. The alpha branching ratios $\lambda_\alpha/\lambda_{tot}$ were obtained by the determination of the ratio of intensities of suitably chosen electron-conversion lines in Gd and Eu nuclei produced from ^{151}Tb and ^{149}Tb nuclei by electron capture and alpha decay, respectively. The obtained values of $\lambda_\alpha/\lambda_{tot}$ are $5 \pm 1.5 \times 10^{-6}$ for ^{151}Tb and $2 \pm 0.6 \times 10^{-1}$ for ^{149}Tb. Alpha reduced widths and hindrance factors F were calculated. (auth)

33977 THE LOW-ENERGY INTERNAL CONVERSION SPECTRUM OF ^{182}W FROM THE DECAY OF ^{182}Ta. Nilsson, O.; Hogberg, S.; Karlsson, S.-E.; El-Sayad, G. M. (Uppsala Univ.). Nucl. Phys., A100: 351-68(1967).

The internal conversion spectrum of low-energy transitions in ^{182}W following the decay of ^{182}Ta was studied using the 50-cm, iron-free spectrometer at Uppsala. Relative conversion line intensities are given together with internal conversion coefficients, multipolarities, and mixing ratios. The energies of the 32- and 43-keV transitions were determined with high precision. The existence of two previously reported transitions could not be confirmed. (auth)

33978 THE DECAY OF ^{155}Dy(10.2h) TO ^{155}Tb AND ^{157}Dy(8.06h) TO ^{157}Tb. Blichert-Toft, P. H.; Funk, E. G.; Mihelich, J. W. (Univ. of Notre Dame, Ind.). Contract AT(11-1)-498. Nucl. Phys., A100: 369-91(1967). (COO-498-62).

The electron-capture decays of ^{155}Dy(10.2 h) and ^{157}Dy(8.06 h) to excited states in ^{155}Tb (5.6 d) and ^{157}Tb(>30 y) were studied with a Ge(Li) detector and a scintillation spectrometer in singles and coincidence. The ^{155}Dy and ^{157}Dy sources were obtained from the ^{154}Gd$(\alpha,3n)^{155}$Dy and ^{156}Gd$(\alpha,3n)^{157}$Dy reactions. More than 50 previously unreported transitions in the decay of ^{155}Dy were observed. The results permit an improvement of the level scheme of ^{155}Tb previously proposed on the basis of internal-conversion-electron data. Most of the observed gamma transitions were incorporated into a level scheme for ^{155}Tb with levels at 65.4 ($5/2^+$), 155.8 ($7/2^+$), 227.0, 271.2, 498.8, 549.9, 640.6, 891.1, 905.3, 1155.3 ($5/2^-$), 1295.0, 1452.1, 1479.4, 1492.6, 1563.5, 1575.1, 1607.5, 1665.1, 1749.8, 1792.7, 1865.6, 1953.6, and 1990.9 keV. Only the levels at 65.4, 155.8, 227.0, 271.2, 498.8, 891.1, 1155.3, and 1665.1 keV were preproposed. The observed gamma transitions in the ^{157}Dy decay were incorporated into a level scheme for ^{157}Tb with levels at 60.8 ($5/2^+$), 143.8 ($7/2^+$), 326.4 ($5/2^-$), 358.0, 597.5, 637.2, 697.4, 992.6 ($3/2^+$), 1044.5 ($5/2^+$), 1096.4, 1102.9, and 1276.1 keV. (auth)

33979 EXCITED STATES OF ^{134}Ba. Julian, Glenn M.; Jha, S. (Carnegie Inst. of Tech., Pittsburgh). Nucl. Phys., A100: 392-400(1967).

The radiations accompanying the decay of 6.5-min ^{134}La were studied with a Gerholm magnetic lens type beta spectrometer and with a 3 mm thick Ge(Li) gamma spectrometer. Scintillation spectrometers were used for beta-gamma and gamma-gamma coincidence experiments. For the gamma rays from ^{134}La, the energies in keV and relative intensities in per cent of decays are 563 (0.5%), 605 (7.4%), 1167 (0.2%), 1424 (0.3%), 1554 (0.7%), 1730 (0.4%), 1957 (0.1%), 1991 (0.1%), and 2081 (0.08%). The following levels of ^{134}Ba are populated (energies in keV given together with estimated log ft values for feeding in the decay of 1^+ ^{134}La): ground state (4.8), 605 (5.7), 1168 (6.5), 2159 (5.7), 2335 (5.9), [2562] (6.3), 2594 (5.7), 2686 (6.3). No evidence is found for the existence of a 0^+ member of a possible second excited state vibrational triplet. (auth)

33980 ALPHA-DECAY STUDIES OF POLONIUM ISOTOPES IN THE MASS RANGE 199 TO 208. Tielsch-Cassel, Edith (CERN, Geneva. Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A100: 425-37(1967).

Alpha spectra and half lives of the isotopes ^{199}Po to ^{208}Po were measured. An electromagnetic isotope separator was used for the preparation of samples, thus helping to establish correct mass assignments and to resolve previous ambiguities. Accurate energies are given for the alpha transitions of the isotopes studied. (auth)

33981 NEW HIGHER LEVELS OF ^{144}Nd IN THE DECAY OF ^{144}Pm. Eissa, Nabil A. (Inst. of Nuclear Research, Debrecen, Hungary); Berenyi, D.; Mathe, Gy.; Varga, D.; Rezanka, I.; Maly, L. Nucl. Phys., A100: 438-48(1967).

The decay of ^{144}Pm was investigated by scintillation and coincidence techniques (well-type crystal, normal and sum coincidence and pile-up elimination) and by a coaxial Ge(Li) detector with special attention to the presence of higher levels of ^{144}Nd. It was found that levels higher (2129.6 and 2235 keV) than 1.78 MeV are also present in the decay of ^{144}Pm. The energy and intensity of all gamma rays in the decay of ^{144}Pm was measured. The total disintegration energy of the ^{144}Pm-^{144}Nd decay is larger than 2235 keV and smaller than 2635 keV. (auth)

33982 PAIRING EFFECT IN FISSION-FRAGMENT CHARGE DISTRIBUTIONS. Konecny, E.; Gunther, H.; Siegert, G.; Winter, L. (Univ., Giessen, Ger. Technische Hochschule, Munich). Nucl. Phys., A100: 465-72(1967).

Nuclear charge distributions for fission fragments of masses 137, 138, and 139 amu, formed in ^{235}U thermal-neutron-induced fission, were measured as functions of their kinetic energies. The results reveal a significant difference in behavior of the charge distribution curves. In particular, the distribution curves for the odd masses A = 137 and 139 are essentially the same for all kinetic energies, while for the even-mass A = 138 mass chain even values of nuclear charge number Z become clearly favored, relative to odd values, at higher fragment kinetic energies. The ratio of the sum of the yields of doubly even nuclei to the sum of the yields of doubly odd nuclei varies by more than a factor of three over the 10-MeV range of energies investigated. The mean nuclear charge does not change significantly with fragment kinetic energy for either the even A = 138 or the odd A = 137 and 139 mass chains. (auth)

33983 THE ENERGY LEVELS OF ^{127}Te. Takemoto, Iwao; Iwashita, Takeki; Kageyama, Seizaburo (Tokyo Inst. of Tech.). J. Phys. Soc. Jap., 23: 153-7(Aug. 1967).

The energy levels of ^{127}Te populated by the decay of ^{127}Sb were investigated. The gamma rays with energies 61.1, 74.6, 154.4, 252.5, 280.5, 290.3, 309.0, 391.5, 405.0, 411.6, 423.7, 440.7, 444.9, 451, 456, 473.0, 501.5, 543.0, 603.6, 624.0, 638.5, 653.5, 666.9, 675.6, 685.2, 698.5, 723.4, 745.4, 783.8, 789.5, 817.3, 820.1, 923.5, 1141.2, 1155.2, and 1291.5 keV were observed by a Ge(Li) detector. The relative intensities of these gamma rays were estimated. The end-point energy of the beta component with the highest energy was measured to be 1.50 ± 0.02 MeV. On the basis of the experimental results, a level scheme of ^{127}Te is proposed. (auth)

33984 DECAY OF ^{134}La. Gono, Yasuyuki; Ishihara, Masayasu; Sakai, Mitsuo (Tokyo Univ.). J. Phys. Soc. Jap., 23: 145-6(Aug. 1967).

Gamma rays in the decay of ^{134}Ce → ^{134}La → ^{134}Ba were investigated with a lithium-drifted germanium detector. Gamma rays of energies 0.605 ± 0.001 and 0.563 ± 0.001 MeV were assigned to the decay of ^{134}La. The log ft values were deduced from the gamma intensities. That for the first beta component from the 1+ parent nuclide ^{134}La to the ground state of ^{134}Ba is 4.81 ± 0.02 and those for the second component to the first 2+ state and the third component to the second 2+ state range from 5.60 ± 0.08 to 5.65 ± 0.11 and from 6.24 ± 0.17 to 6.54 ± 0.99, respectively, depending on the assumed decay schemes. These values indicate that the successive hindrance phenomenon of allowed beta transitions of G-T type in vibrational region exists in the decay treated in the present experiment. (auth)

33985 ENERGY SPECTRA OF INELASTIC SCATTERING OF 28.4-MeV ALPHA PARTICLES. Kumabe, Isao; Ogata, Hiroshi; Kim, Tong-hyuk; Inoue, Makoto; Okuma, Yasuhiko (Kyoto Univ.). J. Phys. Soc. Jap., 23: 147-52(Aug. 1967).

Thin targets of ^{58}Ni, Cu, Ag, Ta and Au were bombarded with 28.4-MeV alpha particles, and the energy spectra of emitted alpha particles were measured at several angles. The experimental values of the peak energies in the energy spectra at 150° arising from the compound-nucleus process were found to be in good agreement with the values of the Coulomb barrier height for an optical-model potential. Prominent features of the energy spectra for Ag are as follows. The differential cross sections at a forward angle (30°) increase with alpha-particle energy, while those at backward angles (more than 90°) decrease with alpha-particle energy. At an intermediate angle (60°) between them, the energy spectrum is nearly flat. General features of the energy spectra for Ta and Au resemble those for Ag except for the low energy parts where the cross sections are decreased by the higher Coulomb barrier. These features may be explained by a mechanism which takes account of the collective excitation of the residual nucleus. (auth)

33986 DETERMINATION OF THE ABSOLUTE DISINTEGRATION RATE OF POSITRON EMITTERS BY THE COINCIDENCE COUNTING OF ANNIHILATION PHOTON PAIRS. Polaczek, Andrej; Altenberger, Andrzej (Univ. of Warsaw). Nukleonika, 12: 355-6(1967).

The operation of two scintillation γ spectrometers with single-channel pulse analyzers with the output of each fed into a coincidence unit is described. The device can be used for the absolute determination of the disintegration rates of positron emitters in the presence of a strong γ-ray background due to other radionuclides. The instrument is based on the principle of the "positron counter" developed by Weale [J. Sci. Instr. 35: 297(1958)], but allows the elimination of calibration by another absolute method. (S.F.L.)

33987 ABSOLUTE SPECTROSCOPIC FACTORS FOR (d,p) REACTIONS ON HEAVY DEFORMED NUCLEI. Siemssen, R. H.; Erskine, J. R. (Argonne National Lab., Ill.). Phys. Rev. Lett., 19: 90-4(July 10, 1967).

A reanalysis of a previously reported experiment on the reaction $^{182}W(d,p)^{183}W$ still shows a serious discrepancy in the absolute spectroscopic factors if the distortion parameters that fit the elastic scattering data are used. Similar deviations exist for (d,p) reactions on other rare-earth and actinide nuclei. (auth)

33988 STUDY OF THE DECAY OF ^{131}Ba WITH A Ge(Li) GAMMA-RAY SPECTROMETER. Karlsson, K. (Chalmers Tekniska Hogskola, Gothenburg, Sweden). Ark. Fys., 33: 47-55(1967).

Gamma rays in the decay of ^{131}Ba were studied using a 2 mm deep by 2.8 cm^2 area Li-drifted Ge solid-state detector and a 1024-channel analyzer. Gamma intensities were determined with a higher precision than was previously reported as most of the rays found in internal conversion spectra are resolved and observed here. Internal conversion coefficients are found by combining these gamma intensities with electron intensities reported previously. Multipolarities and transition intensities are derived. (auth)

33989 DETERMINATION OF L SUBSHELL RATIOS OF PURE M1 TRANSITIONS. Hoegberg, S.; Karlsson, S.-E.; Norberg, C.-H.; El-Farrash, A. H. (Univ. of Uppsala). Z. Phys., 203: 480-7(1967).

L-subshell ratios were accurately measured for two pure M1 transitions of 82.5 keV in ^{166}Ho and 238.6 keV in ^{212}Bi. The results for all the ratios are in fairly good agreement with those obtained from the theoretical calculations by Sliv and Band. (auth)

33990 DECAY OF ^{195m}Pt AND ^{195}Au. Schoenberg, R.; Gfoeller, D.; Flammersfeld, A. (Univ., Goettingen, Ger.). Z. Phys., 203: 453-63(1967). (In German).

The decays of ^{195m}Pt(4.1 d) and ^{195}Au(192 d) were investigated with a Ge(Li) counter and a Ge(Li)-NaI coincidence circuit. The γ spectrum of ^{195m}Pt showed new lines with energies 239.5, 140.7, and 211.1 keV found earlier only in Coulomb-excitation experiments. The γ spectrum of ^{195}Au established a new level of ^{195}Pt at 199.8 keV with single-particle character. These results led to a modified level scheme and modified reduced transition probabilities for the levels of ^{195}Pt. By comparison of the γ spectrum of ^{195m}Pt and ^{195}Au, the ratios of electron-capture branches of ^{195}Au $\rightarrow$ ^{195}Pt decay were determined. (auth)

33991 SURFACE DELTA INTERACTION IN THE TRANSURANIC NUCLEI. Faessler, Amand (Univ., Freiburg i. B.); Plastino, A. Z. Phys., 203: 333-45(1967).

The surface delta interaction (SDI) is employed to calculate the energy of gamma-vibrational and the K = 0, 1, 2, and 3 octupole vibrational band heads in the even-mass transuranic nuclei. The quasi-particle random phase (RPA) and the quasi-particle Tamm-Dancov approximations (TDA) are utilized to solve the Hamiltonian. The resulting energies and gamma transitions are compared with the pairing plus quadrupole (PQF) or octupole (POF) force model and the available experimental data. The agreement between theory and experiment is satisfactory. Only the K = 0, 1, and 2 octupole bands are collective. The K = 3 negative parity state is practically a pure two quasi-particle state. (auth)

33992 β-SPECTRUM OF NATURALLY OCCURRING ^{187}Re. Huster, E.; Verbeek, H. (Univ., Muenster, Ger.). Z. Phys., 203: 435-42(1967). (In German).

The β spectrum of naturally occurring ^{187}Rhenium was measured using the vapor of $(C_5H_5)_2ReH$ as a gaseous source in a "wall-less" proportional counter. The counter was enclosed in a glass envelope and was operated at temperatures up to 150°C. The Kurie plot was found to be a straight line between 1.1 keV and the endpoint at 2.65 ± 0.04 keV. (auth)

33993 FRACTIONIZATION OF THE OCTUPOLE STRENGTH IN ^{90}Zr. Martens, E. J.; Bernstein, A. M. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett., 24B: 669-71(June 26, 1967). (MIT-2098-329).

The ^{90}Zr (α,α') reaction was studied at 31 MeV with 80 keV resolution. Three octupole states were found between 5 and 6 MeV with a total strength of 31% of the lowest 3^- state. This extends the study of the fractionization of the octupole state previously found in the $f_{\frac{7}{2}}$ shell. (auth)

33994 IDENTIFICATION OF SINGLE-PARTICLE STATES IN THE FISSION TRANSITION NUCLEUS ^{235}U. Loveland, W. (Argonne National Lab., Ill.); Huizenga, J. R.; Behkami, A.; Roberts, J. H. Phys. Lett., 24B: 666-8(June 26, 1967).

Fission-fragment angular distributions are reported for the fission of ^{234}U induced with monoenergetic neutrons of energies 200, 300, 400, 500, 600, 700, and 843 keV. Tentative assignments of quantum numbers (K,π) are made for four low-energy single-particle (Nilsson) states in the very deformed ^{235}U transition nucleus. (auth)

33995 GYROMAGNETIC RATIOS OF THE FIRST EXCITED STATES OF ^{122}Te AND ^{124}Te. Bhattacherjee, S. K.; Bowman, J. D.; Kaufmann, E. N. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Phys. Lett., 24B: 651-3(June 26, 1967).

The g factors of the first 2^+ states of ^{122}Te and ^{124}Te were measured to be +0.31 ± 0.03 and +0.22 ± 0.05, respectively. The results are compared with previously reported values and with recent theoretical calculations. (auth)

33996 DECAY OF ^{183}Hf. Motavalledi-Nobar, Y.; Berthier, J.; Blachot, J. (Faculte des Ssciences, Grenoble, France. CEN, Grenoble, France). Nucl. Phys., A100: 45-58(1967). (In French).

The γ-ray spectra of the decay of ^{183}Hf were investigated with NaI(Tl) and Ge(Li) detectors and the β-ray spectra with anthracene detector. Three beta groups of maximum energies 1.54, 1.18, and 1.00 MeV and three intense gamma rays of energies 783, 458, and 73 keV are observed. The β-γ coincidences show that, with the 458-keV γ-ray in the gate, two beta groups (1.54 and 1.00 MeV) are observed, and, with the 783-keV γ-ray, only the beta group of 1.54-MeV appears. Further, the slow γ-γ coincidences show that only the transition of 783-keV is in coincidence with the one of 73 keV strongly converted ($\alpha_k \approx 0.5$), the first one preceding the other. The half life of the level at 73 keV is about 107 ns. A partial decay scheme is proposed. (auth)

33997 DECAY OF THE ISOMERIC STATES OF ^{102}Ag. Bakhru, H. (Yale Univ., New Haven); Morse, R. I.; Preiss, I. L. Nucl. Phys., A100: 145-60(1967). (YALE-2726-H-90).

The ^{102}Ag, ^{102m}Ag, and ^{101}Ag activities were studied using Ge(Li) detectors as well as with scintillation counters. Gamma rays of energies 230, 511, 550, 720, 780, and 1270 keV in the decay of ^{102}Ag are observed to have composite half lives of 4 and 17 min. Three beta groups of energies 3.6, 3.3, and 2.88 MeV were observed to decay with a half life of 4 min, whereas the 2.4-MeV beta group was found to decay with half lives of 4 and 17 min. Various gamma-gamma and beta-gamma coincidence experiments were performed; and based on these results, a decay scheme is proposed for the isomeric states of ^{102}Ag. The results are discussed, and a mass difference of 5.15 MeV between the ^{102}Ag ground state to the ^{102}Pd ground state is obtained. During these experiments a positive identification of 10 ± 1-min ^{101}Ag, 8 ± 1-min ^{100}Ag, and 3 ± 0.5-min ^{99}Ag activities was made. (auth)

33998 THE DECAY OF ^{140}La. Karlsson, S.-E. (Univ. of Uppsala); Svahn, B.; Pettersson, H.; Malmsten, G.; De Aisenberg, E. Y. Nucl. Phys., A100: 113-35(1967).

The beta-ray and internal-conversion spectra from the decay of ^{140}La to ^{140}Ce were investigated using double-focusing spectrometers. Beta branches with end-point energies of 2166 ± 7, 1674 ± 10, 1354 ± 15, and 1244 ± 20 keV were established, giving a Q-value of 3762 ± 8 keV. In the internal conversion spectrum, 26 transitions were found ranging in energy from a previously unreported 24.595 ± 0.004 keV transition up to a very weak transition at 3322 ± 4 keV. The gamma-ray spectrum following the decay of ^{140}La was studied using a Ge(Li) detector. The theoretical K-conversion coefficient for the 1596-keV E2 transition was used to calculate conversion coefficients. From these coefficients together with K/ΣL and L-subshell ratios, probable multipolarity assignments were obtained for most of the transitions. All transitions observed were fitted into a tentative decay scheme. (auth)

33999 K-CONVERSION ELECTRON, GAMMA-RAY ANGULAR CORRELATION STUDIES ON THE DE-EXCITATION OF ^{194}Pt. Alwyn, S.; Butt, D. K. (Birkbeck Coll., London). Nucl. Phys., A100: 177-85(1967).

Angular correlation ($\bar{e}$-γ) studies were made between the radiations from the 293- and 328-keV transitions in ^{194}Pt. The measurements indicate that the M1/E2 γ and E0/E2 K-electron mixtures in the radiation from the 293-keV transition are 1.0 to 3.5% and 1 to 13% respectively, with negative phase in each case where the 293-keV transition is the first component in the cascade. The E0 strength parameter for the transition is deduced to be $\rho = 10.9 \pm 6.6 \times 10^{-3}$. (auth)

34000 THE GAMMA-RAY SPECTRUM OF ^{210m}Bi. Spejewski, E. H. (Indiana Univ., Bloomington). Contract Nonr-1705(02). Nucl. Phys., A100: 236-40(1967).

The gamma spectrum following the alpha decay of the long-lived ^{210}Bi isomer was studied with a Ge(Li) spectrometer. The energies and relative intensities of the lines observed are 265.7 ± 0.2 (100), 304.8 ± 0.3 (54), 329.1 ± 0.8 (≈2), 344.0 ± 1.0 (≈2), 369.6 ± 1.0 (≈1), and 649.8 ± 1.0 (≈4) keV. They are fitted into a level scheme for

^{206}Tl with excited states at 265.7 ± 0.2, 304.8 ± 0.3, 634.5 ± 0.8, and 649.5 ± 0.8 keV. The intensity measurements indicate that the level at 650 keV has a spin of 1 rather than the 2 or 3 previously suggested. No evidence was found for the existence of a proposed ground state doublet with small separation. (auth)

34001 DECAY SCHEME OF 3.9-d ^{127}Sb. Ragaini, R. C.; Gordon, G. E.; Walters, W. B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-905. Nucl. Phys., A99: 547-76(1967). (MIT-905-86).

Beta and γ rays emitted in the decay of 3.9-day ^{127}Sb were studied with the use of Si(Li), Ge(Li) and NaI(Tl) detectors and coincidence equipment; and the level scheme of ^{127}Te was constructed. In order to check on interference from other antimony isotopes, sources were prepared by separating antimony directly from fission products, by milking antimony from separated tin fission products, and by use of the ^{128}Te(γ,p)^{127}Sb reaction followed by chemical separation. A total of 33 γ rays were observed, of which 32 were placed in the level scheme of ^{127}Te. Levels of ^{127}Te populated by decay of ^{127}Sb were observed at the following energies: 61, 88, 341, 473, 503, 631, 686, 764, 784, 786, 924, 1077, 1142, 1155, 1290, 1323, and 1378 keV. The properties of low-lying, even-parity levels of ^{127}Te are in reasonable agreement with the predictions of Kisslinger and Sorensen. Evidence for a $\frac{9}{2}^-$ "intruder" state at 341 keV in ^{127}Te, similar to that at 322 keV in ^{125}Te, was found. Additional evidence for apparent hindrance of allowed β transitions was obtained. (auth)

34002 DECAY OF ^{110,110m}Ag TO ^{110}Cd. Moragues, J. A.; Reyes-Suter, P.; Suter, T. (Comision Nacional de Energia Atomica, Buenos Aires). Nucl. Phys., A99: 652-68(1967).

The decay of ^{110m}Ag to ^{110}Cd was investigated. Internal conversion electrons and beta rays were measured with a double-focusing spectrometer, gamma rays with a Ge(Li) detector, and electron-gamma and beta-gamma coincidences with an orange-type beta spectrometer. Transitions (gamma intensities given in brackets) of the following energies in keV were obtained with an accuracy of about 1 : 10^4: 446.76 (3.5), 620.22 (2.9), 657.72 (100), 677.47 (12.1), 686.88 (7.5), 706.61 (16.8), 744.13 (4.7), 763.86 (23.5), 817.93 (7.5), 884.59 (79.1), 937.32 (35.7), 1384.08 (27.6), 1475.65 (4.4), 1504.81 (14.5) and 1562.06 (1.34). End points and intensities of the following beta-ray branches were determined: 2891 keV (1.4%), 2220 keV (0.1%), 1630 keV (0.08%), and 531 keV (33%). Energies in keV and intensities of the gamma scintillation spectrum of the decay of ^{110}Ag (24 sec) were measured as follows: 658 (100), 770 (0.6), 818 (1.3), 950 (0.7), 1130 (1.0) and 1476 (0.7). (auth)

34003 SYNTHESIS OF THE ISOTOPES OF THE ELEMENT 102 IN REACTIONS WITH MASS NUMBERS WITH OXYGEN IONS. Flerov, G. N.; Polikanov, S. M.; Mikheev, V. L.; Ilyushchenko, V. I.; Kushniruk, V. F.; Miller, M. B.; Sukhov, A. M.; Shchegolev, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 1186-91(June 1967). (In Russian).

The isotopes ^{256}102 ($T_{\frac{1}{2}}$ = 9 ± 3 sec, E_α = 8.42 ± 0.03 MeV) and ^{255}102 ($T_{\frac{1}{2}}$ = 180 ± 40 sec, E_α = 8.09 ± 0.03 MeV) were obtained by bombarding the ^{242}Pu target with ^{18}O ions from the 310-cm heavy ion cyclotron. The isotopes were identified by the excitation functions in nuclear reactions. The data obtained are in good agreement with those obtained at the JINR from the synthesis of these isotopes in the experiments in which ^{238}U was bombarded by ^{22}Ne ions. (auth)

34004 CHARACTERISTIC K-RADIATION OF FRAGMENTS AT THE THERMAL NEUTRON FISSION OF ^{235}U. Eismont, V. P.; Yurgenson, V. A. Yadern. Fiz., 5: 1192-7(June 1967). (In Russian).

Yield and energy distribution are measured of the K-component of the X-ray emitted by fragments after the thermal neutron fission of ^{235}U. The results are compared with the recently obtained data on the properties of the X-ray radiation that accompanies the spontaneous fission of ^{252}Cf. (auth)

34005 ENERGY LEVELS IN ^{176}Lu AND ^{160}Tb DETERMINED IN THE (d,p) REACTION. Struble, Gordon L.; Sheline, Raymond K. (Florida State Univ., Tallahassee). Yadern. Fiz., 5: 1205-20(June 1967). (In Russian).

The energy levels in ^{176}Lu and ^{160}Tb are studied by means of (d,p) reaction spectroscopy. The Q value for the ^{176}Lu ground state is determined to be 4070 ± 8 keV, and the Q value for ^{160}Tb ground state is determined to be 4153 ± 5 keV. A rotational model is used to interpret the energies and to generate state vectors that correspond to the experimental levels. Using these vectors and DWBA, a theoretical (d,p) spectrum is constructed and is compared with the experimental data. Detailed spectroscopic interpretation is not possible for the ^{160}Tb levels. However, in ^{176}Lu, the $\frac{7}{2}^+$[404], $\frac{7}{2}^-$[514] configuration leading to the ground-state rotational band with K = 7 and spin values: 7^- (g.s.), 8^- (186 keV), and 9^- (391 keV) is identified. The K = 0 band with spin 1^- is tentatively suggested at the 127-keV state. The configuration $\frac{7}{2}^+$[404], $\frac{1}{2}$[510] leads to rotational bands in ^{176}Lu with K = 3 and K = 4 at 662 and 791 keV, respectively. The experimental (d,p) intensities of the K = 3 and K = 4 rotational bands can not be interpreted with the theoretical C^2_{j1} coefficients of the Nilsson model, but can be interpreted if the experimental C^2_{j1} values observed for the $\frac{1}{2}$[510] rotational band in ^{177}Yb are used. (auth)

34006 HALF-LIVES OF EXCITED STATES OF ^{115}In. Begzhanov, R. B.; Gladyshev, D. A.; Khodzhaev, M. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz., 5: 1145-8(June 1967). (In Russian).

The experimental data concerning the lifetime measurements of the excited states of the nucleus ^{115}In are presented. The measured lifetimes of the levels at 595, 825, and 858 keV are equal respectively to τ_μ (595) ≤ 2.5 × 10^{-10} sec, $\tau_{\frac{1}{2}}$(825) = 5.6 ± 0.1 × 10^{-9} sec, and $\tau_{\frac{1}{2}}$(858) = 1.52 ± 0.08 × 10^{-9} sec. Some quantum characteristics of the excited levels of ^{115}In are defined more accurately. (auth)

34007 EXCITED STATES OF ^{110}Ag. Estulin, I. V.; Rozantsev, I. N.; Prokof'ev, P. T.; Bondarenko, V. A. (Moscow State Univ. Inst. of Physics, Riga). Yadern. Fiz., 5: 1149-55(June 1967). (In Russian).

The prompt and delayed coincidences and internal-conversion-electron spectra were measured from the reaction ^{109}Ag(n,γ). The 13 excited levels of ^{110}Ag with excitation energy E < 700 keV as well as transitions between them were found. The multipolarities for 11 radiative transitions are indicated. The excited states of ^{110}Ag are represented according to three separated systems of levels; the nonpaired proton doublet states $p_{\frac{1}{2}}$; levels connected with the 117.5-keV isomeric state ($T_{\frac{1}{2}}$ = 37 ± 4 nsec) by M1 transitions; and states connected by enhanced E2 transitions. (auth)

34008 DIFFERENTIAL ELASTIC SCATTERING CROSS SECTION OF 4- TO 8-keV ELECTRONS AT LARGE ANGLES AS A FUNCTION OF THE ATOMIC NUMBER OF THE SCATTERING MATERIAL. Nakhodkin, N. G.; Mel'nik, P. V.; Kryn'ko, Yu. N. (Kiev State Univ.). Ukr. Fiz. Zh., 12: 487-9(Mar. 1967). (In Russian).

Thin targets of Be, Al, Cu, Ag and Au were used in estimating the relative change in the elastic scattering cross section at an angle θ = π with a change in the atomic number of the scattering material. The number of back-scattered electrons was determined over a narrow solid angle. The height of the maximum of the elastically reflected electrons was plotted as a function of the atomic number. The change in the height of the maximum was greater for heavy elements than would be obtained with Rutherford scattering. The experimental data were in agreement with those of Shin-R. Lin, but no simple expression has yet been found to describe the exact relation. (TTT)

34009 STUDIES IN THE DECAY OF THE ACTIVE DEPOSIT OF ACTINIUM. III. LEVELS IN ^{211}Bi AND ITS DAUGHTER PRODUCTS. Davidson, W. F.; Cothern, C. R.; Connor, R. D. (Univ. of Manitoba, Winnipeg). Can. J. Phys., 45: 2295-2313 (July 1967).

Previous work on the decay of ^{211}Pb was developed and was extended using lithium-drifted germanium detectors and sum-coincidence techniques. A more detailed level scheme for ^{211}Bi was produced with greater precision in the determination of the energies and intensities of the 16 gamma rays observed. The alpha decays of ^{211}Bi and ^{211}Po were studied using solid-state detectors with a resolution of 15.5 keV at 6 MeV. The alpha branching of ^{211}Bi to the 350-keV level in ^{207}Tl was found to be 16.43 ± 0.04% and that of ^{211}Po to the 570-keV level in ^{207}Bi to be 0.50 ± 0.07%. The beta-alpha branching ratio in the decay of ^{211}Bi is 0.274 ± 0.004%. The data enable upper limits to be placed on any other alpha groups in the active deposit in the energy range 3 to 13 MeV. The gamma-ray spectrum of separated sources of ^{207}Tl was found to consist of a single transition of energy 898 ± 0.5 keV with an intensity of 0.0024 ± 0.0004 photons per ^{207}Tl decay or 0.0029 ± 0.0004 photons per ^{211}Pb decay. A decay scheme for the entire active deposit is given. (auth)

34010 ENERGIES AND HALF-LIVES OF ISOMERIC LEVELS IN THE NUCLEI ^{139}Ce, ^{141}Nd, ^{161}Ho, AND ^{163}Ho. Geiger, J. S.; Graham, R. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 45: 2281-93(July 1967). (AECL-2901).

A search was made for delayed γ rays with 1 sec ≲ $T_{\frac{1}{2}}$ ≲ 10 min following 10.5-MeV proton bombardment of 18 natural metallic targets. The five activities observed are: ^{139}Ce, E_γ = 754.5 ± 1.3 keV, $T_{\frac{1}{2}}$ = 54.8 ± 1.0 sec; ^{141}Nd, E_γ = 756.8 ± 1.3 keV, $T_{\frac{1}{2}}$ = 60.3 ± 1.0 sec; ^{161}Ho, E_γ = 211 ± 2 keV, $T_{\frac{1}{2}}$ = 6.78 ± 0.15 sec; ^{163}Ho, E_γ = 299 ± 2 keV, $T_{\frac{1}{2}}$ = 1.09 ± 0.03 sec; and a γ ray of 122 ± 2 keV, $T_{\frac{1}{2}}$ = 20 ± 1 sec which is tentatively assigned to ^{179}Ta. All transitions were

measured using a Ge(Li) γ-ray detector. The internal conversion electrons of the transitions in ^{139}Ce and ^{141}Nd were also studied using an orange β-ray spectrometer. Rotational transition energies in ^{158}Dy, ^{164}Er, ^{168}Yb, and ^{174}Hf were measured in conjunction with the internal conversion studies. (auth)

34011 MEASUREMENTS OF NEUTRON RADIATIVE CAPTURE RESONANCE INTEGRALS. LeSage, Leo Gay. Stanford, Calif., Stanford Univ., 1966. 113p.

Thesis.

Neutron radiative capture resonance integrals for thirteen natural elements were measured at the Stanford nuclear reactor. The work was done in beam geometry using a Moxon-Rae counter to detect prompt capture gamma rays. Thin samples were irradiated both with and without a cadmium filter in the beam. Gold, with an assumed resonance integral of 1565 barns, was used as the standard. The resonance integrals were calculated from the data both by the usual cadmium ratio method and by an alternate method which was based on the efficiency characteristic of the Moxon-Rae detector and which utilized only the cadmium-filtered count. The values calculated by the two methods were generally in good agreement. The total count obtained in each run included, in addition to the capture gamma rays, both a constant (no foil) background and a count rate due to gamma ray and neutron scattering in the sample foil. Dummy scattering foils with small capture cross sections (e.g., aluminum, copper, zirconium, tin and lead) were used to determine experimentally a scattering correction. It was necessary to make a calculated self-shielding correction, since the magnitude of the constant background limited, in most cases, the use of progressively thinner foils in order to obtain an accurate experimental extrapolation to zero foil thickness. The self-shielding calculation included corrections for multiple scatterings and Doppler broadening of the resonances. Calculations were also made to determine the effective cadmium cutoff energy for each of the sample foils. Additional corrections were made to the data for radioactive build-up in the sample foils and for differences in the isotopic neutron binding energies when polyisotopic elements were measured. The epicadmium spectrum was calculated with the multigroup, diffusion theory code, AIM 6, and found to have a very nearly 1/E shape. The calculation was confirmed approximately by resonance foil activation measurements. The resonance integral results are as follows: cobalt, 68.0 ± 7 b; niobium, 18.8 ± 4.5 b; molybdenum, 28.7 ± 2 b; rhodium, 1106 ± 50 b; palladium, 88.1 ± 6 b; silver, 752 ± 40 b; indium, 3235 ± 200 b; holmium 696 ± 45 b; hafnium, 2014 ± 200 b; tantalum, 699 ± 40 b; tungsten 327 ± 30 b; rhenium, 856 ± 50 b; and platinum, 141 ± 8 b. These values include the 1/v component and have been corrected to a lower energy limit of 0.5 eV. (TSS) (Disser. Abstr.)

34012 THE DISTRIBUTION OF NUCLEAR CHARGE IN THE LOW ENERGY FISSION OF ^{238}U. Anderson, James Lowell. Gainesville, Fla., Florida State Univ., 1966. 112p.

Thesis.

The distribution of nuclear charge in the fission of ^{238}U with protons of 10 and 12 MeV incident energy was studied. The independent yields of several shielded and quasi-shielded nuclides were determined radiochemically. These yields were compared with predictions based on the equal-charge-displacement, constant-charge-ratio, and minimum-potential-energy prescriptions. It is found that the constant-charge-ratio hypothesis is inadequate to explain the charge distribution in these systems. The equal-charge-displacement hypothesis is most successful when applied in a modified version whereby the most probable charge, Z_p, is predicted by mass equations which neglect the effects of nuclear shell structure. The most successful correlation of experimental data and predicted yields is with the minimum potential-energy hypothesis using Levy's mass equation and the post-fission neutron emission data of Apalin. The independent yield ratios of five isomer parts were also investigated. The results of this study were compared with the prediction that there is a correlation between the position of an isomer pair on the mass yield curve and the independent yield isomer ratio. This hypothesis predicts that isomer pairs in the yield valley are formed by a low angular momentum process and, hence, the low-spin isomer should be favored. The isomer pairs on the yield wings are formed by a relatively higher angular momentum process, so the high spin isomer should be favored. The results of this work indicate there is no simple correlation between the position of an isomer pair on the mass yield curve and the independent yield ratio for the isomers. (Disser. Abstr.)

34013 BREMSSTRAHLUNG PRODUCTION BY 50 KeV AND 100 keV ELECTRONS. Placious, Robert Charles. Washington, D. C., Catholic Univ. of America, 1965. 203p.

Thesis.

Bremsstrahlung radiation was produced and measured for electrons of 50- and 100-keV incident energy from a cascade transformer rectifier type electron accelerator. For each electron energy the absolute photon flux per incident electron was measured as a function of the energy and angle of the emitted photon, and as a function of the target atomic number, thickness and target inclination angle to the incident electron beam. For this work a specially designed scintillation type spectrometer was used in conjunction with a specially designed demountable target chamber which permitted convenient changing of target parameters. The results give the continuous spectra for bremsstrahlung photons after empirical corrections are made for the effects of the spectrometer resolution, the characteristic x-ray lines, and the absorption in the target. The target absorption correction estimate was obtained by a series of reflection-transmission measurements on the same target. The differential spectra are integrated graphically to obtain the total radiation and hence the production efficiencies. The efficiencies are given as a function of target thickness and atomic number and are presented in two ways—as a ratio of radiated power to actual energy loss, and to incident electron energy. In addition, some typical radiation patterns (angular distributions of the radiated energy) are given. Also it is shown that electron backscatter, which is a strong function of the target inclination angle yields considerably different total radiated power for different inclination angles of the same target. The nonrelativistic calculations of Kramers and of Sommerfeld-Kirkpatrick-Wiedmann show good agreement with the experimental results for the case in which the spectra are integrated over the photon emission angles provided electron backscatter is excluded for Kramers but included for Sommerfeld-Kirkpatrick-Wiedmann. The Monte Carlo calculations of Berger and Seltzer which include empirical relativistic corrections show better agreement with the experimental results for the direct comparison of the differential spectra without integration over the photon emission angle. The measured production efficiencies for thick targets have been compared to estimates of various authors and show that the proportionality constant in the simple empirical relation: ϵ (Efficiency) = rZT_0 to have a best value of $1.02 \pm 0.15 \times (10^{-6})$ per keV before backscatter correction and $1.74 \pm 0.26 \times (10^{-6})$ per keV after backscatter correction. (Disser. Abstr.)

34014 INTERMEDIATES IN THE NUCLEON TRANSFER PROCESS IN REACTIONS OF ^{14}N WITH ^{133}Cs. Morse, Robert Ira. New Haven, Yale Univ., 1966. 175p.

Thesis.

The radionuclides ^{134m}Cs, ^{132}Cs, ^{131}Cs, ^{130}Cs, ^{129}Cs, ^{128}Cs, and ^{127}Cs were observed by standard radiochemical techniques in the heavy ion reactions of ^{14}N + ^{133}Cs, at the Yale University Heavy Ion Accelerator. Angular distributions, differential and average ranges and excitation functions were measured. The angular distributions of ^{130}Cs, ^{129}Cs, and ^{127}Cs, at 140 MeV incident energy, are superimpossible, peaking at 34° (FWHM 19°) in the laboratory. These products also exhibit virtually superimpossible recoil ranges over an incident energy range of 60 MeV to 140 MeV with a recoil energy of 2 MeV at 140 MeV. The total cross sections for the products ^{130}Cs through ^{127}Cs, at 140 MeV, was found to be 250 ± 35 mb whereas the cross-section for ^{132}Cs was 160 mb. At this energy, upper limits of 0.2 ± 0.2 mb and 30 ± 10 mb have been set for the production of ^{131}Cs and ^{128}Cs respectively. The ^{132}Cs angular distribution exhibits a maximum at 78° in the laboratory and a projected recoil range of 0.5 MeV at 140 MeV incident energy. The production of the ^{132}Cs has been attributed to a direct transfer process. Based on kinematic arguments, a mechanism of direct excitation by neutron transfer in a peripheral collision followed by de-excitation via nucleon emission has been proposed in order to explain the production of the isotopes ^{130}Cs through ^{127}Cs. Based on this model, the average recoil ranges were calculated and found to be in excellent agreement with experimental values. The angular distributions were fit by the direct transfer "equivalent two-body" formalism of Strutinskii. Monte Carlo calculations of statistical evaporation from the proposed excited intermediates, ^{132*}Cs and ^{131*}Cs, yielded cross sections in excellent agreement with experimental values. (Disser. Abstr.)

34015 NUCLEON TRANSFER PROCESSES IN REACTIONS OF HEAVY IONS WITH ^{115}In. Strudler, Paul Michael. New Haven, Yale Univ., 1966. 250p.

Thesis.

The systematics and occurrence of nucleon transfer processes in the reactions of ^{12}C and ^{14}N with ^{115}In at energies in excess of the Coulomb barrier were subjected to experimental investigation. Excitation functions and average recoil ranges were radiochemically determined for single and multi-nucleon transfer reactions leading to In, Sn, and Sb products. Upper limits for the production of cadmium (charge exchange) and silver products were established. From the yield distribution of these products which the recoil

range studies have shown to be formed in direct processes, it is noted that charged particle pickup by the indium nucleus occurs with much greater probability than charged particle stripping, and that there is a significant cross section for multi-neutron loss by the indium nucleus. The former effect was rationalized in terms of the level density of states available for the products of the transfer reaction. Certain patterns in the excitation functions for these products are consistent with the existence of nucleon clustering phenomena. The characteristics of the multi-neutron loss data may be interpreted as evidence for a mechanism of inelastic excitation of the indium nucleus followed by multi-neutron emission. Trends in the recoil range data were compared to the predictions of simple kinematic models. The following characteristics were noted: single nucleon transfer reactions, as previously suggested, proceed primarily via a quasi-elastic surface interaction, wherein the motion of the interacting nuclei may be represented by classical Rutherford trajectories; multi-nucleon transfer may also proceed by a quasi-elastic interaction. The importance of this process is a function of the sum of the masses of the reactants, the beam energy, and the number of particles transferred; and there is a considerable cross section for multi-nucleon transfer to the target in "grazing" type collisions. The kinematics of these events can be approximated by a calculation in which the linear momentum of the nucleons absorbed by the target nucleus must be considered, as well as the Coulombic scattering of the projectile residue. The total transfer cross section is of the order of several hundred millibarns. (Disser. Abstr.)

34016 SEVERAL NEW NEUTRON DEFICIENT ISOTOPES OF SILVER. Doty, Duane Robert. Los Angeles, Univ. of California, 1966. 92p.

Thesis.

The production of ^{101}Ag and ^{99}Ag with (p,2n) and (p,4n) reactions on Pd targets was observed. The targets were enriched to 50.9% ^{102}Pd. Respective half lives of 10.8 ± 0.2 min and 106 ± 10 sec were measured. A complex positron spectrum for ^{101}Ag resolved into energies and intensities of 3.38 MeV (10.0%), 2.73 MeV (43.6%), 2.18 MeV (22.6%), 1.56 MeV (17%), 1.08 MeV (6.2%), and 0.85 MeV (0.6%). For ^{99}Ag only three branches were observed at 3.32 MeV (59.2%), 2.43 MeV (23.9%), and 1.69 MeV (16.9%). Nine gamma transitions from 83 keV to 1164 keV were identified as belonging to the decay of ^{101}Ag, while six gamma transitions ranging from 660 keV to 3315 keV were observed to accompany the decay of ^{99}Ag. The γ spectrum energies and intensities, measured with the aid of a Ge detector, are correlated with $\gamma-\gamma$ and $\beta-\gamma$ coincidence in order to propose the level schemes. The energy available for decay, in the case of ^{101}Ag, was measured to be 4.665 ± 0.08 MeV, which agrees favorably with a semi-empirical mass-law calculation of 4.668 MeV. A measurement of the intense 263 keV ground-state transition conversion coefficient dictates a positive parity assignment for the first excited energy level in ^{101}Pd. A comparison of the energy for the threshold of production for ^{99}Ag and the related energy for decay agrees well with the semi-empirical mass law. The decay energy was found to be 6.04 ± 0.1 MeV, as compared to the theoretical 6.245 MeV. Preliminary information for ^{100}Ag indicates a (p,3n) production occurring at 28 ± 0.5 MeV, which is in good agreement with theoretical values. A half-life of 7.5 ± 1 min was measured for the high energy positron branch which has an end point at 6.5 ± 0.5 MeV. Two intense gamma transitions at 556 and 728 keV also were observed with the same half-life. (Disser. Abstr.)

34017 COULOMB EXCITATION IN ODD-A RARE-EARTH NUCLEI. Bishop, Edwin Vandewater. New Haven, Yale Univ., 1966. 453p.

Thesis.

The spectroscopy of the low-lying collective levels of the odd-A nuclei ^{159}Tb, ^{165}Ho, and ^{175}Lu was studied by detecting the deexcitation gamma radiation following Coulomb excitation with oxygen ions up to 65 MeV in energy. Information is presented both on the level structures and on the reduced electromagnetic transition probabilities between some of the states, and these are discussed within the framework of existing collective models. The most striking deviation from the usual axially symmetric quasi-rigid rotor model occurs in ^{159}Tb, in the form of a higher-order decoupling type term similar to the well-known Coriolis decoupling term in intrinsic K = ½ bands. An analysis of possible mechanisms is presented and it is concluded that either band mixing involving a strongly decoupled band or centrifugal stretching of the core can explain the form of the energy perturbation. Although an experimental choice between the mechanisms was not possible, it is concluded that the stretching mechanism could account for the substantial part of the decoupling which a band-mixing calculation using an intrinsic matrix element computed from Nilsson wave functions does not account for. Magnitudes of the higher Coriolis and the usual vibration-rotation type perturbations in the ground-state bands were measured. Gamma-vibrational states are located in the three nuclei, and reduced transition probabilities for their excitation, referred to ground-state band Q_0 values, are given. (Disser. Abstr.)

34018 DECAY SCHEMES OF SHORT-LIVED FISSION PRODUCT NUCLEI. Riehl, Jerry A. Pullman, Wash., Washington State Univ., 1966. 162p.

Thesis.

The decay schemes of ^{97}Zr, ^{97}Nb, ^{176m}Lu were investigated. Gamma- and beta-ray analyses, gamma–gamma and beta–gamma coincidence measurements, and half-life determinations were performed. High-resolution lithium-drift germanium detectors and sodium iodide scintillation crystals were employed in the gamma-ray analyses. A double-focusing beta spectrometer was used for the beta-conversion electron analyses. A three crystal gamma–gamma coincidence spectrometer was used, with a 4096 channel dual-parameter analyzer, to collect the gamma–gamma coincidence data. Beta-gamma coincidence data were obtained with a spectrometer system that included a 4096-channel dual-parameter analyzer, sodium iodide detection for the gamma rays, and lithium-drift silicon solid-state detection for the beta rays. A description of the beta-gamma coincidence detector system, is included. Several previously unreported gamma rays, beta rays, gamma-gamma coincidences, and beta-gamma coincidences were observed. The half-lives of ^{97}Zr, ^{97m}Nb, and ^{97}Nb were measured and were found to be 16.5 ± 0.05 hr, 58.7 ± 1.2 sec, and 70.9 ± 0.2 min, respectively. Previously unreported excited levels are assigned to ^{97}Nb at 2496 keV and 1279 keV, and more precise energies are reported for the other excited levels. The energies of the published excited levels in ^{97}Mo were also redetermined. Three previously unreported excited states at 476, 1280, and 1626 keV are reported. The conversion ratio of the 659.4-keV transition in ^{97}Mo is calculated. The result establishes that the de-excitation proceeds by the emission of M2 or E3 gamma radiation. Two previously unreported excited levels are reported for ^{176}Hf at 1060 keV and 1249 keV. The energy of the first excited rotational state was determined as 88.8 ± 0.04 keV. The results are compared to recent theoretical calculations, and tentative decay schemes are proposed for each nuclide. (Disser. Abstr.)

34019 INVESTIGATION OF THE DECAY SCHEME OF ^{145}Eu. Hill, John Christian. Lafayette, Ind., Purdue Univ., 1966. 106p.

Thesis.

The decay scheme of ^{145}Eu was studied by means of the techniques of beta and gamma spectroscopy. The isotope was made by bombardment of $^{144}Sm_2O_3$ with 9.5-MeV deuterons. Europium was chemically separated from other elements using ion-exchange techniques. The half-life was measured to be 5.93 ± .1 days. Thirty-three gamma transitions were identified by means of NaI and Ge gamma detectors and magnetic beta-ray spectrometers. Gamma-gamma coincidences using both NaI and Ge detectors were performed. From this information a decay scheme was constructed. Most of the transitions were incorporated into the decay scheme in a consistent manner. A positron spectrum containing two branches was observed using the magnetic spectrometer. Also the conversion coefficients of several transitions were measured, and the multipolarities were determined. All transitions were E1, M1, or E2 in character. Measured log-ft values indicated that most of the electron-capture transitions were first forbidden in character. The level scheme of ^{145}Sm has a first excited state at 0.895 MeV and a second excited state at 1.437 MeV. Above 1.5 MeV the level density greatly increases. Levels of both even and odd parity were observed. The energy of the first excited state is consistent with that of other nuclei containing 83 neutrons and an even number of protons. The energy difference between the ^{145}Sm and the ^{145}Eu ground states is about 2.75 MeV, in good agreement with theory. It is difficult to determine whether the first excited state of ^{145}Sm is a single neutron state or a proton pair state. Careful determination of the spin of the first excited states of several nuclei with 83 neutrons and an even number of protons is needed. (Disser. Abstr.)

34020 NUCLEAR BETA SPECTROSCOPY USING SOLID STATE DETECTORS. Trischuk, John Michael. Pasadena, Calif., California Inst. of Tech., 1967. 80p.

Thesis.

The beta decay shape factor of the 4.8 minute isotope ^{207}Tl is measured to be $(0.0423 \pm 0.0006)[1 + (0.024 \pm 0.010)W]$ using solid state detectors. The result is interpreted in terms of the shell model. The properties of the solid state beta spectrometer are described. (Dissertation Abstr.)

Nuclear Theory

Refer also to abstracts 33872, 33874, 33875, 33891, 33911, 33914, 33915, 33927, 33932, 33946, 33954, and 33955.

34021 (AD-637700) VARIATIONAL METHODS FOR SCATTERING PROBLEMS. Report No. 29. Kolsrud, Marius (Oslo Univ. (Norway). Inst. for Theoretical Physics). Dec. 22, 1965. Contract AF-EOAR-32-64. 35p. (AFOSR-66-1014). CFSTI.

The variational method of Schwinger is extended, and leads to several new stationary expressions for the phase shifts and for the scattering amplitude. Numerical examples are given. (auth)

34022 (INP-525/PL) REAKCJE JADROWE BEZPOSREDNIEGO ODDZIALYWANIA. (Direct Nuclear Reactions). Niewodniczanski, Henryk; Strzalkowski, Adam (Institute of Nuclear Physics, Krakow (Poland)). Mar. 1967. 74p. (In Polish). Dep.

A report on the present state of investigations of direct nuclear reactions is given. A general review of the formalisms usually applied is presented. Starting with the most advanced coupled-channel method, different models of direct reactions are consecutively discussed, namely the DWBA-model, PWBA-model, and also some adiabatic approximations for the particular case of inelastic scattering. The possibilities of extracting information concerning the nuclear structure are also discussed. (auth)

34023 (INP-544/PL) INFLUENCE OF THE EXPERIMENTAL ERRORS ON THE DETERMINATION OF THE OPTICAL MODEL PARAMETERS FOR ALPHA PARTICLES. Budzanowski, Andrzej; Dymarz, Rafal; Grotowski, Kazimierz; Strzalkowski, Adam (Institute of Nuclear Physics, Krakow (Poland)). 1967. 18p. Dep.

The angular distribution of 24.7-MeV alpha particles scattered elastically on Co nuclei was analyzed by means of the optical model of the interaction. The influence of different kinds of experimental errors on this analysis was studied. These errors are as follows: individual errors of successive experimental points in the angular distributions, the error in the absolute value of the cross-section, the error in the estimation of the zero point of the angular scale, and error in the measurement of the energy of incident particles. (auth)

34024 (JINR-P05-3180) OBOBSHCHENNYE FUNKTSII BOGOLYUBOVA I ELEMENTY PRICHINNOI S-MATRITSY. (The Bogolubov Distributions and the Causal S-Matrix Elements). Khodzhaev, L. Sh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 17p. (In Russian). Dep. mn.

A class of the Bogolubov distributions is introduced and a number of their important properties is found. The causal S-matrix elements are expressed in terms of the Bogolubov distributions. (auth)

34025 (JINR-P4-3300) REAKTSII S PERERASPREDELENIEM CHASTITS. II. METOD MNOGOKANAL'NOI SVYAZI. (Reactions With Rearrangement of Particles. II. Multichannel Coupling Method). Efimenko, T. G.; Zhigunov, V. P.; Zakhar'ev, B. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 17p. (In Russian). Dep.

A method of describing scattering processes, which are accompanied by particle rearrangement within the unified theory of nuclear reactions, is suggested. The problem is reduced to the solution of a system of non-homogeneous differential equations and of a system of simple algebraic equations. This method allows one also to take into account the Pauli principle for scattered particles and to describe the reactions in which the number of fragments in the final state is more than two. This paper presents a considerable improvement of the method of truncated asymptotics. (auth)

34026 (JINR-P4-3325) SPIN-ORBITAL'NOE VZAIMODEISTVIE V TYAZHELYKH DEFORMIROVANNYKH YADRAKH. (Spin-Orbital Interaction in Heavy Deformed Nuclei). Gareev, F. A.; Ivanova, S. P.; Kalinkin, B. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 12p. (In Russian). Dep.

The effects of the spin-orbit interaction on the structure and positions of single-particle states in axially symmetric deformed heavy nuclei is investigated. (auth)

34027 (JINR-P4-3329) PARNYE KORRELYATSII SVERKHPROVODYASHCHEGO TIPA DLYA YADER V OBLASTI $100 < A < 256$. (Pairing Correlations of the Superconducting Type for Nuclei in the Energy Region $100 < A < 256$). Malov, L. A.; Solov'ev, V. G.; Khristov, I. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 18p (In Russian). Dep.

Pairing energies for spherical and deformed nuclei in the region $100 < A < 256$ are calculated using the superfluid nuclear model. It is shown that pairing energies calculated with the constants $G_Z = 27A^{-1}$ MeV and $G_N = 23A^{-1}$ MeV for all the nuclei in the region $150 < A < 256$ agree sufficiently well with experimental data. For the nuclei in the region $100 < A < 150$, the values of G_Z and G_N decrease and approach each other. The correlation functions for the ground states of even-even and odd-mass nuclei are obtained, and the peculiarities of their behavior are discussed. The schemes of one-particle levels and calculated values of the chemical potentials are given. The data are presented in the form convenient to be used for different numerical estimates while studying the properties of the nuclei considered. (auth)

34028 (LYCEN-6663) TRAITEMENT GRAPHIQUE DE LA GEOMETRIE D'UN PROBLEME DE PHYSIQUE NUCLEAIRE. APPLICATION AUX POTENTIELS NON-LOCAUX. (Graphical Treatment of the Geometry of a Nuclear Physics Problem: Application to Nonlocal Potentials). Massot, Jean Noel (Lyon Univ. (France). Institut de Physique Nucleaire). Dec. 1966. 181p. (In French). Dep.

Thesis.

The Yutsis et al. graphic representation of the Racah algebra is not complete in three points. It ignores the spherical harmonic functions, the irreducible tensors, and the rotation matrices. This question is studied and developed. The graphic methods thus developed are extremely general and can be used with any problem. The second point in the incompletion of the representation is that when a physics problem necessitates the decoupling of a spin $\vec{J}$ into "n" spins $\vec{j}$; it is necessary to make the decomposition step by step and analytically with the aid of Clebsch–Gordan coefficients. The graphic method can be used only after conversion of the Clebsch–Gordan symbols into "3-j" coefficients. In order to avoid the analytical decomposition and the conversion (C–G) → ("3 – j") then the transcription of these latter symbols into graphic elements, triangular diagrams are introduced. This scheme is completed with the aid of an algorithm which makes it possible to construct instantaneously the initial phase. It is then seen how the ensemble of the method makes it possible to effect analytically all the operations bearing on the elements encountered in the kinetic moment theory. A nonlocal stripping interaction is then studied and the general expression for the differential cross section is given. (tr-auth)

34029 (NIM-80) RESOLUTION OF PHOTOPEAKS OBTAINED FROM THE PRODUCTS OF STABLE NUCLIDES IRRADIATED BY NEUTRONS. Uken, E.-A.; Faure, P. K. (National Inst. for Metallurgy, Johannesburg (South Africa)). Sept. 14, 1966. 21p. Dep.

The radioactive products obtained from the irradiation of stable nuclides with neutrons are considered. All the known products are presented in a simple graphical form from which the existence of mutually interfering photopeaks can easily be read. All the results included were obtained with a 400-channel analyzer and a 3 in. × 3 in. NaI(Tl) crystal. (D.C.W.)

34030 (ORNL-4125) A FORTRAN IV PROGRAM FOR CALCULATING GENERAL TENSOR MOMENTS OF POLARIZATION IN NUCLEAR REACTIONS AND SCATTERINGS. McCulloch, R. D.; Graben, H. W.; Thornton, S. T.; Willard, H. B. (Oak Ridge National Lab., Tenn.). July 1967. Contract W-7405-eng-26. 96p. Dep. CFSTI.

A computer program for calculating the most general tensor moments of polarization was developed. Tensor moments of outgoing particles from a two-body final state reaction are calculated explicitly in terms of the tensor moments of the initial state particles, the scattering or reaction matrices, and the energy and angles. The computer program is organized into two parts. The first part computes the generalized tensor moments of polarization for the outgoing particles in terms of the tensor moments of the incoming particles, the reaction matrices, and the rotation matrices (D functions). In the second part the output of Part I can be rearranged according to J^π values; specific numerical values of the incoming tensor moments and particular values of the scattering angles, (θ,φ), defining the D functions can be input. The final output of the tensor moments depends only on the nuclear dynamics (or reaction matrices). Several options are available throughout the program. (auth)

34031 (ORO-2915-79) THEORETICAL NUCLEAR PHYSICS. Progress Report. Rose, Morris E. (Virginia Univ., Charlottesville. Dept. of Physics). June 1967. Contract AT(40-1)-2915. 21p. Dep. CFSTI.

NUCLEI — meson (μ^-) capture by, neutron angular distribution from polarized (T)
NUCLEAR REACTIONS — theory of quasielastic scattering
ELECTRONS — reactions with nuclei, with quasielastic scattering (T)
PROTONS — reactions with nuclei, with quasielastic scattering (T)
CALCIUM-40 — meson (μ^-) radiative capture by, structure-dependent terms in (T)
BORON-11 — photon reactions (γ,π^+) with, calculations using independent-particle model with impulse approximation
ATOMS — electron separation energies for, calculations using many-body perturbation theory

ATOMS—interaction potentials for, long-range (T)
OXYGEN—atomic interaction potentials for, long-range (T)
HYDROGEN—electron inelastic scattering with 1s-2s excitation, cross-section calculations using optical model potential
IRON—electron correlation energies for (T)
NUCLEI—meson (π) absorption with double nucleon emission, orbital (T) (D.C.W.)

34032 (PUC-937-262) CORE POLARIZATION EFFECTS IN MASS 15 AND MASS 17. Shukla, Agam Prakash (Princeton Univ., N. J. Palmer Physical Lab.). May 1967. Contract AT(30-1)-937. 146p. Dep. CFSTI.

Thesis.

The effects of residual interaction are investigated in (^{16}O ± 1 nucleon) nuclei. Wave functions of the $\frac{1}{2}^-$ and $\frac{3}{2}^-$ states of ^{15}O and ^{15}N are constructed by mixing the single-hole spherical and (2p−3h) deformed configurations. The even-parity states of mass 15 are constructed by mixing the (1p−2h) and (3p−4h) deformed states. The Nilsson model is used for constructing the intrinsic states; and the physical, deformed states (members of the rotational bands) are obtained by angular momentum projection. The effective charge for the E2 transitions among odd-parity states of mass 15 is calculated by taking account of the contribution of the 2^+ states of the ^{16}O core. An effective quadrupole-quadrupole force is used for the lowest 2^+ states while Hamada-Johnston realistic matrix elements are used to construct the T = 0 and T = 1 RPA vibrations. The eigenfunctions and eigenvalues thus obtained agree well with the previous calculations and the ^{16}O(γ,n)^{15}O and ^{16}O(e,e′)^{16}O scattering data. The (E2/M1) mixing ratio of the ($\frac{3}{2}^-$ 6 MeV → $\frac{1}{2}^-$ g.s.) transition in mass 15 is calculated. The phase of the calculated values agrees with experiment. The magnitude of x(E2/M1)^{15}O is in good agreement with experiment while the agreement for x(E2/M1)^{15}N is fair. It is found that 75% of the E2 amplitude of ^{15}O is due to the effective charge. In ^{15}N, the importance of the effective charge is not as large (~50% of the E2 amplitude). The ($\frac{3}{2}^-$ 6 MeV → $\frac{1}{2}^-$ g.s.) transition is found to be predominantly single hole M1 both in ^{15}O and ^{15}N. The electromagnetic decay of the 5-MeV doublet, 6.79-MeV $\frac{3}{2}^+$, 8.29-MeV $\frac{3}{2}^+$, and 8.74-MeV $\frac{1}{2}^+$ states of ^{15}O is also calculated. For the electric transitions, the wave functions are treated as Hill-Wheeler integrals; and a delta-function approximation is used. For the magnetic multipoles M1 and M2, the Nilsson model is used. The transition amplitude is due to the odd particle with core effects accounted for by using appropriate gyromagnetic ratios. The partial decay widths, lifetimes, and branching ratios for the above levels are calculated. Agreement with experiment is good. The ft value for the ^{15}O → ^{15}N ground state decay is calculated. Comparison with experiment indicates that best agreement is obtained with a 10% deformed admixture in the ground state. The spectroscopic factors of the $\frac{1}{2}^-$ and $\frac{3}{2}^-$ states of mass 15, for single-nucleon pickup reactions ^{16}O(p,d)^{15}O etc., are also calculated. Agreement with experiment is again good for 10% deformed admixture. From this, and the calculations of electromagnetic decay of the levels of mass 15, it is concluded that the ground state has a 10% deformed (2p−3h) component. Spectroscopic factors were also calculated for the odd-parity states of ^{17}O in the deuteron stripping reaction ^{16}O(d,p)^{17}O. It is concluded from this calculation and on the basis of previous work that the low-lying odd-parity states of ^{17}O are predominantly (2p−1h). The calculated spectroscopic factors are in poor agreement with measured values. Therefore, the relevance of the weak coupling model as an alternative to constructing these states, is discussed. (auth)

34033 (LA-tr-67-15) HYDRODYNAMIC CALCULATION OF EFFECTIVE MASSES OF BINARY NUCLEAR FISSION. Hasse, Rainer W. Translation of Preprint. 56p. Dep. CFSTI. JCL $5.60 fs, $1.88 mf.

The kinetic energy of the asymmetric and symmetric fission process is calculated for the possible intermediate configuration up to the breaking point of the nucleus without the Wheeler condition. It is assumed that a surface deformation produces hydrodynamically ideal flow of the incompressible nuclear material. (D.C.W.)

34034 (NP-tr-1543) STUDIES OF NUCLEAR REACTIONS. Skobel'tsyn, D. V. (ed.). Translation of Tr. Fiz. Inst., Akad. Nauk SSSR, 33: 1-273(1965). 230p. Plenum Publ. Corp., New York $22.50.

A separate abstract was written for one of the papers included. All others have previously appeared in Nuclear Science Abstracts from the original source. (S.F.L.)

For abstracts of individual papers see: 33873.

34035 CORRELATION ENERGY OF ^{16}O. Brown, G. E. (NORDITA, Copenhagen); Wong, C. W. Nucl. Phys., A100: 241-7(1967).

The correlation energy, i.e., the zero-point energy of vibrations and particle-hole excitations, is calculated for ^{16}O. This involves choosing a model space consisting of 0s, 0p, 1s, 0d, 1p, and 0f levels and then defining an effective force for this model space in terms of a reaction matrix so calculated that only intermediate states outside of the model space are employed. Plane-wave intermediate states are used as intermediate states. The effective Hamiltonian is then diagonalized in the model space, using quasi-boson commutation relations. This is equivalent to summing the ring diagrams in the graphical expansion of the energy with some exchange included. (auth)

34036 ALPHA DECAY TO VIBRATIONAL LEVELS IN DEFORMED ODD-MASS NUCLEI. Dumitrescu, O.; Sandulescu, A. (Univ. of Helsinki). Nucl. Phys., A100: 456-64(1967).

The influence of the residual interaction between quasi-particles and phonons on alpha-decay rates in deformed odd-mass nuclei is analyzed. The decay constant is given explicitly. The hindrance factors (HF) for two intrinsic states and their rotational bands in ^{237}Np and ^{239}Np are computed. It is shown that the mixture of the β-vibrational state and the quasi-particle state corresponding to favored transitions lowers very much the hindrance factors. (auth)

34037 AN EFFECTIVE, RESIDUAL INTERACTION FOR SHELL-MODEL CALCULATIONS. Pandharipande, V. R. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., A100: 449-55(1967).

A modified δ-function, effective, residual interaction is proposed for nuclear, shell-model calculations. The interaction V^{12} is defined as follows: $\langle j_1 j_2 J|V^{12}|j_3 j_4 J\rangle = \alpha_J \langle j_1 j_2 J|V\delta(r_1 - r_2)[1 - \beta + \beta(\sigma_1 \cdot \sigma_2)]|j_3 j_4 J\rangle$, where $\alpha_J = 1$ if $J \neq j_1 \pm j_2$, $J \neq j_3 \pm j_4$, and $\alpha_J = a + bJ$ if $J = j_1 \pm j_2$ or $J = j_3 \pm j_4$. Calculations with this interaction are presented in ^{18}O, ^{38}Cl, ^{42}Ca, ^{54}Fe, ^{90}Zr, ^{92}Nb, ^{92}Zr, and ^{210}Bi. The interaction gives good agreement in all these isotopes with the following values of the parameters: V = 1630 MeV·fm^3, β = 0.1, a = 0.42, and b = 0.05. Calculations in even tin and odd indium isotopes are also presented. (auth)

34038 LINEAR POTENTIAL MODEL FOR THE BINDING ENERGY OF A FINITE NUCLEUS. Donnelly, I. J.; Naqvi, M. A. (Univ. of Sydney). Nucl. Phys., A100: 305-15(1967).

A single-particle model for the investigation of the energy parameters for large nuclei is developed. It compares favorably with the Hartree-Fock method and is easier to handle. (auth)

34039 GAMMA MAGNETIC RESONANCE. Mitin, A. V. (Physical-Technical Inst., Kazan). Zh. Eksp. Teor. Fiz., 52: 1596-1602(June 1967). (In Russian).

Two-quantum resonance in the Mössbauer effect, which is a process consisting of simultaneous absorption of a Mössbauer quantum and a quantum of the external r-f field, is considered. The calculation is performed for Mössbauer nuclei embedded in a ferromagnet. In this case the main contribution to γ-ray absorption is from nuclei located in the Bloch walls. The analysis shows that transitions forbidden in one-quantum processes are allowed by γ magnetic resonance. Estimations show that an experimental detection of the lines should be feasible. (auth)

34040 ENERGY LOWER BOUNDS FOR TRANSLATION-INVARIANT N-FERMION SYSTEMS. Hall, R. L. (London Univ.). Proc. Phys. Soc. (London), 91: 16-22(May 1967).

A restriction on the choice of translation-invariant coordinates for a system of N identical fermions, interacting by pair forces, allows a lower bound to be established on the ground-state binding energy. This bound is the sum of the first N − 1 eigenvalues of a two-particle problem. The quality of the method is found to depend on the choice of coordinates consistent with the initial restraint, the optimum set giving a bound which, in the case of Hooke's law pair forces, is $\sqrt{3}(N - 1)/2(N + 1)$ times the exact energy. (auth) (UK)

34041 DEUTERON STRIPPING ANALYSIS. Butler, S. T.; Hewitt, R. G. L.; McKellar, B. H. J.; May, R. M. (Univ. of Sydney). Ann. Phys. (N.Y.), 43: 282-321(June 16, 1967).

A new method is developed for the study of deuteron stripping reactions. The aim is to circumvent a difficulty associated with the usual DWBA approach, i.e., that the approximation of assuming zero internal deuteron distortion is made in a matrix element which receives its contributions from that region of configuration space within or near the initial nucleus. As this is the same region in which deuteron polarization is likely to be most important, it may be that the DWBA approach is inherently incapable of yielding accurate determinations of spectroscopic factors. The cross section is expressed in terms of a matrix element which differs in form from that usually employed, while an explicit function $S/(1 - S)^2$ of the spectroscopic factor S emerges as a multiplying factor. It appears that this form for the cross section has the following advantages: in the matrix element involved, the deuteron elastic scattering wavefunction contributes primarily in the asymptotic region of configuration space for which there is no in-

ternal deuteron distortion, while effects arising from the neutron and proton influenced differently by the core nucleus appear in terms of neutron and proton optical wavefunctions only; a large part of the structure, or S, dependence of a specific reaction has been extracted in the factor $S/(1-S)^2$ so that the matrix element itself is less sensitive to specific structure details than the usual DWBA matrix element; and an evaluation of the differential cross section depends primarily on a knowledge of neutron and proton optical wavefunctions, and the results are not significantly dependent on any particular choice of optical model parameters provided these are consistent with nucleon scattering data. Differential cross sections were calculated for six ground-state reactions covering a wide range of mass numbers; comparisons with experimental results are highly encouraging. (auth)

34042 POLARIZATION IN (d,p) STRIPPING REACTIONS. May, R. M.; Truelove, J. S. (Univ. of Sydney). Ann. Phys. (N.Y.), 43: 322-37(June 16, 1967).

The polarization of outgoing protons in (d,p) stripping reactions is calculated, using the approximation method developed in the preceding paper to express the incident deuteron wavefunctions. This method involves only neutron–nucleus and proton–nucleus optical potentials. The theoretical calculations are compared with experimental polarization results for a variety of (d,p) reactions, with the orbital angular momentum quantum number for the captured neutron varying from 0 to 3. Theory and experiment are in substantial agreement. (auth)

34043 ANALYTIC STRUCTURE OF THE TWO- AND FOUR-POINT FUNCTION IN A SOLUBLE MANY-FERMION MODEL. Dahmen, Hans D. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Ann. Phys. (N.Y.), 43: 242-62(June 16, 1967). (MIT-2098-254).

The analytic properties in the energy variables of the one- and two-particle propagator are investigated on the basis of an exact solution of an N-particle model with a simplified and separable two-body potential. (auth)

34044 STATES CLOSE TO SINGLE QUASI-PARTICLE STATES IN ODD DEFORMED NUCLEI. Solov'ev, V. G.; Fogel', P. (Joint Inst. for Nuclear Research, Dubna, USSR). Dokl. Akad. Nauk SSSR, 171: 69-72(Nov. 1, 1966). (In Russian).

The energies and wavefunctions of states near one-quasiparticle states in odd deformed nuclei in the range $153 \leq A \leq 183$ were calculated, and the effects of impurities in the one-quasiparticle states on the magnitude of decoupling parameters and on spectroscopic factors for direct nuclear reactions are described. (R.V.J.)

34045 INVESTIGATION OF DIFFUSION OF NUCLEAR REACTION RECOIL PRODUCTS IN DIFFERENT MATERIALS. Tarantin, N. I.; Gordeev, V. V.; Dem'yanov, A. V. At. Energ. (USSR), 22: 280-5(Apr. 1967). (In Russian).

The results of tests on the study of the time of emission of nuclear reaction products contained in heated sheets were reported. It was found that approximately 50% of the Dy atoms driven into Ta sheets at 1750°C are admitted in a time of approximately 0.1 sec. The tests were made with the purpose of investigating this method for the introduction of reaction products to be studied into ion sources of the electromagnetic separator designed for fast identification of short-lived nuclear products. (tr-auth)

34046 ANGULAR DISTRIBUTION OF γ RAYS EMITTED FROM EXCITED NUCLEI. Dzhrbashyan, V. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1281-5(Aug. 1966). (In Russian).

Cross sections of multiple electromagnetic excitations were previously obtained considering the contributions of nuclear forces and spin magnetic moments of arbitrary spin particles. The data indicated that the cross sections of the 2^λ-polar magnetic spin excitation was proportional to $I(I+1)\mu_p^2$, where μ_p is a value considered for determining the vector of the spin magnetic moment equal to $2\mu Z_p\mu_p$ (in nuclear magnetons) and can be expressed by the cross section of the $2^{\lambda+1}$-polar electric excitation. An attempt was made to show that a similar situation exists in the investigations of angular distribution of γ rays. Expressions were developed which in addition to the mixed multiple orbital excitation took into account multiple excitation caused by spin magnetic moment of particles with arbitrary spins. Several individual cases were analyzed. An expression was developed for multiplicity mixture M1 + E2 with the obtained $\frac{1}{2}$ coefficient of the corresponding expression in the work of L. C. Biedenharn et al. [Phys. Rev. 104, 1643(1956)] and for M1 transition and particle spin in which the $\frac{1}{2}$ parameters of particle $b_\nu^{m\ spin\ 1}$ coincided with the magnitudes in above wave at $\nu = 0$ and differing by a $\frac{1}{4}$ coefficient at $\nu = 2$. (R.V.J.)

34047 EVALUATION OF CORRECTIVE TERMS IN THE THEORY OF DIRECT NUCLEAR REACTIONS. I. CORRECTION OF NONCOMMUTATIVITY IN SUDDEN APPROXIMATION. Berlaimont-Schyns, D. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg. (5), 52: 1507-15(1966). (In French).

The correction for the noncommutativity of the Hamiltonians in the case of the stripping reaction $^{28}Si(d,p)^{29}Si$ is evaluated. (D.C.W.)

34048 EVALUATION OF CORRECTIVE TERMS IN THE THEORY OF DIRECT NUCLEAR REACTIONS. II. ORTHOGONALITY OF INITIAL AND FINAL WAVE FUNCTIONS. Tompa, J. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg. (5), 52: 1516-22(1966). (In French).

A method for obtaining the transition amplitude between mutually orthogonal states for a general rearrangement collision is applied to stripping and pick-up reactions and is evaluated for the reaction $^{28}Si(d,p)^{29}Si$. (auth)

34049 OPTICAL MODEL FOR THE ELASTIC DEUTERON SCATTERING. Baumgaertner, G. (Technische Hochschule, Munich). Z. Phys., 204: 17-31(1967).

An optical model for the elastic scattering of deuterons by nuclei is derived from first principles. The influence of the Pauli principle is investigated in nuclear matter and is found to be small. Surface effects due to the finite size of the deuteron are studied in terms of a perturbation expansion. The first-order term agrees well with the 100-MeV fit of the real potential depth to the experimental data; the second order term is shown to be two orders of magnitude smaller. (auth)

34050 INCREASE IN THE YIELD OF NUCLEAR REACTION RODUCTS WHEN A SINGLE CRYSTAL TARGET IS USED. Iferov, G. A.; Pokhil, G. P.; Tulinov, A. F. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.), 5: 201-3(Apr. 15, 1967).

Translated from Zh. Eksp. Teoret. Fiz., Pis'ma Redakt., 5: 250-3(Apr. 15, 1967).

The reaction D(d,p)T was studied in a single crystal of Nb that was impregnated with D to an atom-number concentration of 1%. It was observed that the reaction-product yield increased when the beam-channeling conditions were satisfied. (D.C.W.)

34051 APPROXIMATION BY THE HARTREE–FOCK METHOD WITH PARITY MIXING. Mueller-Schwartz, Joachim (Univ., Neuchatel, Switzerland). Z. Phys., 203: 389-419(1967). (In German).

The quantitative behavior of parity-mixing in the approximation of Hartree-Fock is examined using one-particle functions without definite parity (PHF). With the aid of a variational method (at most one variation parameter for each particle and self-consistent treatment of the OPEP alone), it is found that the mixing will be large if the mixing parameters are taken as purely imaginary (with our choice of phase), that is if the product wave function is time reversal invariant. In this case the parity-mixing will be produced by exchange terms alone and only long-range forces can contribute substantially. Therefore, the OPEP can be considered a good approximation of parity-mixing forces. The correct magnitude of the single-particle energy splittings which are produced in the usual treatments by the LS-term of the shell model is obtained. (auth)

34052 EXAMINATION OF THE TIME-DEPENDENT ABSORPTION FROM TWO ADJACENT DECAYS BY MEANS OF THE MOESSBAUER EFFECT. Albrecht, Klaus; Neuwirth, Wolfgang (Univ., Heidelberg). Z. Phys., 203: 420-34(1967). (In German).

Using the Mössbauer effect in ^{57}Fe, the time-dependent transmission of gamma rays through a resonating absorber with electric quadrupole splitting was examined. The theory, which is in good agreement with former measurements in the single-level case, is now extended to absorbers with doublet lines. Theoretical and experimental results agree within the limits of error. Applications of the experimental method for the determination of small splittings are discussed. (auth)

34053 INELASTIC NEUTRON SCATTERING BY EVEN–EVEN NUCLEI. Korolev, A. M. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 716-22(May 1967). (In Russian).

Accounting for pair correlations in inelastic scattering of neutrons by even-even nuclei is considered on the basis of the following simple phenomenological model. It is supposed that two extra neutrons out of the core form a pair in the singlet deuteron-like s-state and a wave function of the two extra neutrons may be presented as a product of a pair gravity center function and a relative coordinate function. The inelastic scattering process is attended by pair excitation in the potential field of the core or pair breakup. The angular distribution of the inelastic neutron scattering in the Born approximation is obtained in these two cases and is compared to simple one-particle model results. The numerical calculation of the scattering neutron angular distribution is made for the ^{40}Ca nucleus. The comparison of the theory with the experiment shows that the experimental data are well explained by the pair and one-particle models with not very large angles. (auth)

34054 SURFACE CORRELATIONS IN ^{6}Li. Bang, J. (Univ. of Copenhagen); Hansteen, J. M. Phys. Lett., 24B: 645-6 (June 26, 1967).

Based on the application of wave functions for ^{6}Li created in a Saxon-Woods potential well, it is argued that Coulomb interaction processes involving small momentum transfers yield information about surface clustering effects. (auth)

34055 AKHIESER–POMERANCHUK–BLAIR MODEL FOR ELASTIC SCATTERING. Sen Gupta, H. M. (Univ. of Dacca, East Pakistan); Rahman, M.; Khan, A. H. Austral. J. Phys., 20: 265-70(June 1967). (AECD/TP-11).

The semiclassical APB model is employed in analyzing the angular distribution of protons elastically scattered from Fe, Cu, and Ag; deuterons from Ni, Zr, Ag, and Er; ^{3}He-particles from Cd and I; and α particles from I. Effects of different parameters are studied and the best-fit parameters obtained. (auth)

34056 INTERFERENCE BETWEEN LEVELS IN NUCLEAR REACTIONS. Barker, F. C. (Australian National Univ., Canberra). Austral. J. Phys., 20: 341-4(June 1967).

The cross section for a nuclear reaction is considered in which one of the product nuclei is unstable, with two or more levels contributing to its decay. A formula has been derived from R-matrix theory for the case in which contributions come from only a single level of the nucleus with a given spin and parity. The many-level generalization of this formula is given, based on analogy with the form of the cross section for a simple two-stage reaction. Applications to some ^{8}Be levels are considered. (S.F.L.)

34057 COLLECTIVE EFFECTS AND THE HYDRODYNAMIC APPROXIMATION IN NEUTRON SCATTERING FROM FLUIDS. Ferziger, Joel H.; Feinstein, David L. (Stanford Univ., Calif.). Phys. Rev., 158: 97-105(June 5, 1967).

The scattering law is investigated for gases and liquids. It is shown that the convolution approximation ignores perturbations caused by the test particle for $t > 0$. For a dilute gas, a normal-mode expansion of the Boltzmann equation is made to estimate the size of the "collective effects" contribution to the scattering law. It is found that for small energy and momentum transfers the "collective effects" contribution dominates the solution. The hydrodynamic and convolution approximations are compared to experimental results for liquid sodium. (auth)

34058 POLARIZATION IN (d,p) REACTIONS FROM THE WBP MODEL. Bang, J. M.; Pearson, C. A.; Pocs, L. (Univ. of Copenhagen). Nucl. Phys., A100: 24-32(1967).

The proton polarization predicted by an approximate form of the weakly bound projectile (WBP) model for (d,p) reactions is compared with measured polarization. Qualitative fits are obtained, using the same set of parameters which previously gave good fits to the magnitude and shape of six selected angular distributions. It is shown that the main features of the proton polarization arise from the proton-target nucleus scattering. In most cases studied, the polarization is essentially identical to the elastic scattering polarization, as previously indicated by Pearson and Cóz. The agreement between the observed and predicted polarization supports their basic physical picture. (auth)

34059 DIFFERENTIAL CROSS SECTIONS FOR (d,p) REACTIONS FROM THE WBP MODEL. Bang, J. M. (Univ. of Copenhagen); Pearson, C. A. Nucl. Phys., A100: 1-23(1967).

A detailed study is made of the weakly bound projectile (WBP) model for (d,p) reactions. Differential cross sections calculated from an approximate form of the model are reported for six reactions on closed-shell, spin-zero targets ranging from ^{16}O to ^{88}Sr. Good fits were found for the six angular distributions with the spectroscopic factor S = 1 and one fixed set of nucleon-nucleus parameters. It is shown how the WBP model gives insight into the stripping mechanism. Certain features of the cross sections can be attributed to the transferred neutron; others arise mainly from the scattered proton. The results support the basic picture of WBP. A more refined version of the WBP model should thus be useful for extracting accurate spectroscopic factors from stripping measurements. (auth)

34060 P_4 DEFORMATION IN AN INDEPENDENT-PARTICLE MODEL OF LIGHT NUCLEI. Brihaye, C. (Univ., Libre, Brussels); Reidemeister, G. Nucl. Phys., A100: 65-73(1967).

The level $|\Omega|^{\pi} = \frac{1}{2}^{+}$ originating in the spherical sub-shell $1d_{\frac{1}{2}}$ seems to play a prominent part for light nuclei. The influence of a $P_4(\cos\theta)$ deformation added to the usual spheroidal potential is calculated for the 1p and 1d-2s shells. It is shown that this deformation acts selectively on the $\frac{1}{2}^{+}$ level. Experimental data concerning ^{19}F appear to support the assumption of permanent P_4 deformations. (auth)

34061 PROJECTED HARTREE–FOCK CALCULATION FOR LIGHT NUCLEI. I. ENERGIES AND WAVE FUNCTIONS. Bouten, M. (SCK, Mol, Belg.); van Leuven, P.; Depuydt, H.; Schotsmans, L. Nucl. Phys., A100: 90-104(1967).

An approximate projected Hartree–Fock calculation was carried out for the low-lying levels of nuclei with $4 \leq A \leq 8$. The two-body interaction used is Volkov's potential no. 1. The calculated binding energies are compared with those from other variational methods. With respect to the shell-model approximation, a considerable increase is obtained, which reaches 15 MeV for ^{8}Be. The orbitals, resulting from the minimization of the energy, can be looked upon as approximate eigenfunctions of a deformed oscillator potential. The systematics of size and deformation of these orbitals are presented. The deformation is larger for the orbitals of the inner ^{4}He core than for the orbitals of the outer particles. (auth)

34062 ELECTRO-EXCITATION OF GIANT DIPOLE RESONANCES IN MEDIUM-HEAVY, SPHERICAL NUCLEI. Drechsel, D.; Toepffer, C. (Univ., Frankfurt am Main). Nucl. Phys., A100: 161-7(1967).

The collective intermediate structure of the giant resonances in medium-heavy, spherical nuclei, which was discovered by photonuclear experiments, has been explained nearly quantatively by the collective dynamic theory, which takes into account the coupling of giant-dipole and surface-quadrupole resonance. However, photonuclear experiments determine essentially only the excitation energy and the dipole strength of the various levels. In order to gain more insight into the model, electro-excitation experiments should be carried through. At moderate momentum transfer ($q = 1\ \mathrm{fm}^{-1}$ to $1.5\ \mathrm{fm}^{-1}$), such experiments could test the details of the transition charge distribution predicted by the collective theory. Since the various giant resonance levels have different admixtures of surface phonons, their transition densities and therefore the resulting cross sections show a different behavior. (auth)

34063 PARITY MIXING IN DEFORMED HARTREE–FOCK CALCULATIONS. Parikh, J. (Tata Inst. of Fundamental Research, Bombay. Univ. of Copenhagen); Ullah, Nazakat. Nucl. Phys., A99: 529-39(1967).

It is shown that parity non-conserving single-particle orbitals can result from a self-consistent calculation. Different types of single-particle orbitals are examined for the simple case of two levels of opposite parities to determine the best variational solution. The results of detailed numerical calculations are reported for some nitrogen and oxygen isotopes. (auth)

34064 ANALYSIS OF THE REACTION ^{16}O(n,α)^{13}O AT 14 MeV BY THE DISTORTED-WAVE METHOD. Lamot, G. H.; Fayard, C.; Massot, J. N.; El Baz, E.; Lafoucriere, J. (Univ., Lyon). Nucl. Phys., A99: 633-51(1967). (In French).

The ^{16}O(n,α)^{13}C reaction is studied by using the DWBA method. The following combinations are investigated: knock-on and heavy particle stripping and pick-up and heavy particle stripping. The differential cross sections are theoretically calculated using a graphical method. The results obtained are then compared with the plane-wave results. (auth)

34065 EFFECTIVE RANGE THEORY FOR MULTI-CHANNEL SCATTERING. Kermode, M. W. (Univ. of Liverpool). Nucl. Phys., A99: 605-24(1967).

By considering a simple model for alpha-alpha scattering, the effects on the S-wave phase shift resulting from the first excited state of the alpha particle are investigated. Assuming that each channel contains a Coulomb repulsive field together with a hard core, effective-range formulas for the multi-channel scattering problem are derived. From the results, the formulas for no hard core and/or no Coulomb field are written down. Special attention is given to the two-channel problem. The importance of these formulas is that the strongly energy-dependent phase shifts can be expressed in terms of slowly varying functions of energy, the M-matrix elements. (auth)

34066 EIGENVALUE METHOD FOR SOLUTION OF PARTICLE MODELS FOR ATOMIC NUCLEI IN THEIR SADDLE-POINT DEFORMATION. Dickmann, Friedrich (Kernforschungszentrums, Karlsruhe, Ger.). Z. Phys., 203: 141-72(1967). (In German).

To study saddle-point states of fissioning nuclei in the single-particle model, nucleon wave functions and energy levels for highly deformed nuclei are needed. A method is developed to calculate single-particle wave functions and energy eigenvalues for potentials with any axially symmetric deformation. For that purpose, the eigenvalue problem for the partial differential operator H is replaced by a discrete approximation. A special method is worked out to solve the resulting algebraic eigenvalue problem. (auth)

34067 EXCITATION SPECTRA OF ODD–ODD NUCLEI AND GROUND STATE ISOBAR ANALOGUES OF EVEN–EVEN NUCLEI.

Birbrair, B. L. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 5: 1198-1204(June 1967). (In Russian).

The equations for the density matrix of the superfluid atomic nuclei are obtained. The equations for the odd–odd nucleus excitation spectrum are derived. The results obtained are applied to the analysis of the nature of analog states from the point of view of the finite Fermi–system theory. (auth)

34068 EFFECT OF NONLOCAL CURRENTS ON THE VALUES OF MAGNETIC DIPOLE MOMENTS OF NUCLEI. Korolev, A. M. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 353-9(Mar. 1967). (In Russian).

During motion of particles in a local self-consistent potential the magnetic dipole moments of the nuclei in accordance with the one-particle model are determined by the Schmidt lines. It is shown that if the self-consistent potential is nonlocal, a nonlocal addition to the magnetic moment arises, owing to the existence of nonlocal currents in the nucleus. This addition leads to deviation of the magnetic moments from the Schmidt lines. The dipole magnetic moments are calculated for the special form of the nonlocal potential with divided variables. It is shown that the qualitative agreement of theory with experiment is obtained only in the case of j-j coupling. (auth)

34069 TWO-PARTICLE CORRELATIONS IN MANY-FERMION SYSTEMS. Westhaus, Paul Anthony. St. Louis, Washington Univ., 1966. 279p.

Thesis.

A description is given of systems of fermions governed by a given Hamiltonian which contains realistic two-body interactions. An independent-quasiparticle model is assumed for defining the basic functions for the system. In most instances, the method is limited to the ground-state description of extended systems. (S.F.L.)

34070 SEPARABLE POTENTIALS FOR THE TWO-NUCLEON SYSTEM. MacKenzie, James John. Minneapolis, Univ. of Minnesota, 1966. 84p.

Thesis.

Expressions are derived for non-local separable potentials which will reproduce (with stated restrictions) the two-body scattering phase shift and bound state energy. The quantity, $\sin \delta$, is required to be of one sign only. If the phase shift changes sign, more than one separable potential is required. To handle this situation a model employing one attractive and one repulsive potential is introduced, and a one-parameter family of solutions is obtained. Tensor forces are treated by the introduction of a non-local separable interaction which connects different values of angular momenta. The bound state wave function is found in terms of the scattering data and bound state energy. The results of numerical calculations for the singlet and triplet S waves of the nucleon-nucleon system are presented and discussed. (Disser. Abstr.)

34071 OPTICAL-MODEL INVESTIGATION OF ELASTIC NEUTRON SCATTERING. Cassola, Robert Louis. Athens, Ohio, Ohio Univ., 1966. 198p.

Thesis.

The primary goal of the present investigation is to perform a complete analysis of all of the available elastic neutron scattering data for incident neutron energies between 6 and 24 MeV and, by so doing, to determine as completely as possible the functional dependence and the range of validity of the complex nuclear potential. The basic ideas relating to nuclear reactions are considered and the role which the complex-potential model plays in the description of the elastic scattering process are examined. Some of the more formal aspects of the theory are then discussed. The implementation of the complex-potential model is discussed and the specific goals of the present investigation are enumerated. A detailed discussion of the experiments which were analyzed in this study and those features of the complex-potential model which are firmly established by the analysis are given. It also contains a discussion of those aspects of the model for which the results of the investigation are ambiguous. A new approach is made to the problem of elastic scattering from a complex, non-local potential. It is shown that a closed-form expression for the scattering phase shifts can be obtained if the scattering potential is assumed to be separable. (TSS)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 32293, 32518, 32951, 33007, 33845, 33847, and 33859.

34072 (AECL-2671) DEVELOPMENT OF THE ZIRCALOY COOLANT TUBE TO END FITTING JOINT FOR NPD II. Beston, P. G. (Canadian General Electric Co. Ltd., Peterborough (Ontario). Civilian Atomic Power Dept.). Aug. 13, 1959. 35p. (R-59CAP15). Dep. CFSTI. CAN $1.00.

Rolled joints were developed between 20% cold-worked Zircaloy II pressure tubes, 3¼ in. ID × 0.163 in. nominal wall thickness and type 410 stainless steel fittings. The mechanical strength of the joints was determined and the leak tightness studied under reactor conditions of temperature and pressure with and without applied bending moments. (auth)

34073 (AECL-2874) U_3Si AS A NUCLEAR FUEL. Chalder, G. H.; Bourns, W. T.; Feraday, M. A.; Veeder, J. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). May 1967. 20p. (CONF-670522-1). Dep. CFSTI. CAN $0.50.

From International Conference on World Review of Nuclear Reactors and Radioisotopes, Montreal, Canada.

The relevant properties of U_3Si are reviewed and recent CRNL results on aqueous corrosion and irradiation behavior are discussed. Economic studies are presented which indicate savings of 0.1-0.2 mill/k Wh by substituting U_3Si for UO_2 as the fuel in CANDU type reactors. (auth)

34074 (AECL-2890) HEAT-TREATED Zr-2.5 PERCENT Nb PRESSURE TUBES FOR WATER-COOLED POWER REACTORS. Evans, W.; LeSurf, J. E.; Thomas, W. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). May 1967. 18p. (CONF-670522-2). Dep. CFSTI. CAN $0.50.

From International Conference on World Review of Nuclear Reactors and Radioisotopes, Montreal, Canada.

Results are presented of a research program to develop Zr-Nb alloy pressure tubes for water-cooled power reactors. The alloy tubes produced have acceptable corrosion resistance, higher strength, and when heat-treated will oxidize no more than Zircaloy-2 under reactor conditions; in addition H pickup per unit area will be less. (P.G.C.)

34075 (AI-65-Memo-212) STATISTICAL SAFETY EVALUATION OF POWER REACTORS. Willis, C. A. (Atomics International, Canoga Park, Calif.). Oct. 20, 1965. 12p. Dep. CFSTI.

The standard maximum credible accident approach to safety evaluation is reviewed briefly and its shortcomings are noted. The statistical approach and its advantages are outlined. An example is presented in which the MCA-type accident does not determine the reactor hazard. The development of the statistical approach is discussed and it is concluded that conditions are propitious for general application of stochastic methods. Appropriate advances are suggested. (auth)

34076 (ANL-7342) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, MAY 1967. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 139p. Dep. CFSTI.

Summaries of progress are presented concerning the EBWR Pu recycle program, EBR-II operation and shutdown, physics experiments in ZPR-3, development of ZPPR and AARR, burnup measurements for fast reactors, Na technology, fuel development and processing, reactor physics development, fuels and cladding development and fabrication, heat and fluid flow, fluoride volatility process development, liquid metal direct conversion generator research, and research on nuclear safety. (J.C.W.)

34077 (APDA-CFE-9) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT. Monthly Report No. 9, April 1967. McCarthy, J. F. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). June 1967. Contract AT(11-1)-865. 31p. Dep. CFSTI.

An operations history of the Fermi Fast Breeder is given. This includes the unloading of subassemblies from the reactor vessel lattice. One subassembly was shipped to Battelle Memorial Institute for analysis. Assembly of the fuel inspection facility is discussed. Piping and ventilation modifications are outlined. The installation of new sodium level detection probes is discussed. (M.L.S.)

34078 (BNWL-442) EFFECTS OF UO_2 CRYSTALLINE BINDING ON DOPPLER COEFFICIENTS CALCULATIONS FOR FAST REACTOR SYSTEMS. Schenter, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1967. Contract AT(45-1)-1830. 12p. Dep. CFSTI.

The change in the Doppler coefficient due to crystalline binding effects was studied for ^{238}U in a UO_2 lattice for fast reactor systems. The "weak binding," or the short compound nucleus lifetime (SCNL) approximation was used, where the ^{238}U atoms in the UO_2 lattice are treated as a free gas with an effective temperature. Calculations were made to determine the dependence of effective temperature versus temperature using the experimental phonon distribution of Dolling, et al. Comparisons were also made with effective temperatures obtained assuming a Debye model for the crystal. It was found that for temperatures above 300°K the effective temperature dependence was well represented by the Debye model (θ_D ~620°K). The temperature dependence of the reactivity was calculated for the ANL critical assembly, ZPR-III, 47, with the result that incorporation of the crystalline binding effects caused the calculated Doppler coefficient (dk/dT) to diverge from the "1/T" rule in the low temperature region, in qualitative agreement with the experimental results of Reynolds and Stewart. (auth)

34079 (BNWL-SA-1111) FLUCTUATION MEASUREMENT OF REACTOR POWER. Sheff, James R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1967. Contract AT(45-1)-1830. 12p. (CONF-670602-18). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

An evaluation of the use of neutron fluctuations for measuring absolute reactor power is presented. The space-dependent neutron spectral density function and reflector effects are considered. Variations between space-dependent and space-independent assumptions are examined, and reasons for such variations are discussed. Methods of reducing the variations are outlined. (M.L.S.)

34080 (BNWL-SA-1129) THE LMFBR COMPUTER CONTROL CENTER. Driver, G. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1967]. Contract AT(45-1)-1830. 5p. (CONF-670314-4). Dep. CFSTI.

From Liquid Metal Instrumentation and Control Symposium, Idaho Falls, Idaho.

Conventional control with a digital data logger, digital supervisory control of analog loops, complete digital computer control and data acquisition are components under study of a computer processing center to control reactor, heat exchanger, and power generation equipment. Such a center is considered as part of the LMFBR program. (J.C.W.)

34081 (CVNA-283) STUDY OF REACTOR TRANSIENTS. Final Report. Geets, J. M.; Rajagopal, V. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). June 1967. Contract AT(30-1)-2289. 50p. Dep. CFSTI.

For Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.

Dynamic measurements using noise analysis and reactivity computer techniques carried out at various times in CVTR are summarized. In noise analysis, a sharp resonance was observed at 0.8 cps, and a few measurements were performed to investigate the effect of reactor operating conditions on the resonance. Although further investigations were planned on this peculiar resonance during operation with high power density assemblies, they were not carried out due to premature failure of the special assemblies. Reactivity computer measurements indicate that such techniques are valuable for heavy water reactors. An analysis of reactor transients under postulated accidental conditions was prepared to justify a reactor power increase to 61.7 MW(t) from the previous licensed power of 44.3 Mw(t). Also, new set points were derived for the Reactor Control and Protection System for safe operation at the new power level. (auth)

34082 (DRP/ML/FAR R-184) PHENIX: VERSION INTEGREE. SUSPENSION DE LA CUVE PRINCIPALE. (Phenix: Integrated Version. Suspension of the Main Vessel). Gollion, H. J.; Vautrey, L. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec. 22, 1965. 9p. (In French). Dep.

The main vessel is proposed to be hanged by elastic hangers close to the Na level. The vessel is thus divided into two parts: the lower part essentially subjected to mechanical stresses, the upper part subjected to thermal stresses. (auth)

34083 (DRP/ML/FAR R-188) PHENIX: VERSION INTEGREE. BILAN A LA FIN JANVIER 1966. (Phenix: Integrated

Version. Status of the End of January 1966). Robin, M. G.; Vautrey, L. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb. 10, 1966. 28p. (In French). Dep.

The single vessel reactor concept is recalled. The anticipated advantages and the problems inherent in the proposed Phenix design are given. The present stage of the studies is presented for each of these problems. Their solutions do not present any major difficulties. (auth)

34084 (EUR-2757.e) NUCLEAR GAS TURBINE POWER PLANT COLLOQUIUM, O.E.C.D. HEADQUARTERS, PARIS, MAY 24-25, 1965. (European Nuclear Energy Agency, Paris (France)). 1966. 433p. (DP-Report-380; CONF-650582).

The uses, from both design and economic aspects, of gas turbines in high temperature gas-cooled reactors are discussed. The advantages and difficulties incurred in operation and design of the gas turbine systems are detailed. Materials and fabrication of these systems are discussed. Coolant effects are briefly considered. Separate abstracts were prepared for each of 16 papers presented. (M.L.S.)

For abstracts of individual papers see: 34085–34099 and 34146.

34085 (EUR-2757.e, pp 13-) POTENTIALITIES OF NUCLEAR GAS TURBINE POWER PLANTS. Shepherd, L. R.; Hintermann, K. O. (European Nuclear Energy Agency, Paris (France)). 7p.

A description of the Dragon gas turbine system is given. An evaluation of systems performance is presented. Possible limiting factors for the operation of a system similar to Dragon are discussed. The advantages of using a closed cycle gas turbine are briefly outlined. (M.L.S.)

34086 (EUR-2757.e, pp 21-) HIGH TEMPERATURE GAS COOLED REACTORS WITH STEAM CYCLES. Stadie, K. B. (European Nuclear Energy Agency, Paris (France)). 20p.

The steam cycle work for high temperature gas cooled reactor power plants is reviewed. Performance, cost, reliability, and safety of the steam cycle in conjunction with this reactor concept are investigated and its future prospects are briefly assessed. (auth)

34087 (EUR-2757.e, pp 41-) THERMODYNAMICS OF THE DIRECT GAS TURBINE POWER CYCLE FOR HTGC REACTORS. von Bonsdorff, M. G. (European Nuclear Energy Agency, Paris (France)). 38p.

A parametric study of the thermodynamics of the closed gas turbine cycle as the power conversion of a high temperature gas cooled reactor power plant is presented. The effects of changing thermodynamic variables and component design parameters on net plant efficiency, turbine pressure ratio and recuperative heat exchanger size were computed. A random sampling method has been used to estimate the probability of a predicted value of net plant efficiency. He was assumed as working gas but Ar and air are considered for comparison. (auth)

34088 (EUR-2757.e, pp 83-) MAGNETOHYDRODYNAMIC POWER CONVERSION SYSTEMS FOR THE HTGC REACTOR. von Bonsdorff, M. G. (European Nuclear Energy Agency, Paris (France)). 16p.

The use of magnetohydrodynamic power conversion systems for the high temperature gas cooled reactor is described. Significant features of the layouts involving such systems are detailed. The thermodynamics of an MHD system are presented. (M.L.S.)

34089 (EUR-2757.e, pp 107-) AN ASSESSMENT OF THE EFFICIENCIES AND COMPONENT SIZES OF NUCLEAR CLOSED-CYCLE GAS TURBINES OF 250-MW OUTPUT, USING ARGON AND HELIUM. Ainley, D. G.; Barnes, J. F. (National Gas Turbine Establishment, Farnborough (England)). 36p.

The results of an investigation to determine component sizes for closed cycle gas turbines of 250 MW output, using either He or Ar as working fluids at maximum pressures of 40 atmospheres are given. In all the cycles investigated the gas turbine working fluid also acts as the coolant of a high temperature gas cooled reactor. With the maximum gas temperatures in any cycle governed by the long time creep limitations of uncooled turbine rotor blades, it is shown that a recuperative heat exchanger and one stage of intercooling are needed to obtain a gross thermal efficiency exceeding 40%. Because much of the capital cost of a gas turbine plant is strongly dependent on the bulk of the heat exchange equipment and because the thermal efficiency is sensitive to pressure losses, the disadvantages of He in turbomachinery design seem to be outweighed, particularly in applications demanding a high thermal efficiency. Ar could be attractive in applications without recuperative heat exchangers where simplicity, low bulk and low cost of turbomachinery are of prime importance, e.g., "packaged" power plants and some marine applications. (auth)

34090 (EUR-2757.e, pp 147-) EXPERIENCE WITH CLOSED CYCLE GAS TURBINES. Spillmann, W.; Keller, C. (Escher Wyss G.m.b.H., Zurich (Switzerland)). 28p.

Typical performance parameters of closed-cycle gas turbines are presented. Effects of operation on system components is discussed. The layout of a closed-cycle helium turbine for a nuclear power plant is presented. (M.L.S.)

34091 (EUR-2757.e, pp 179-) ABOUT THE OPTIMUM LAYOUT OF NUCLEAR GAS TURBINE POWER PLANT. Bammert, K. (Technische Hochschule, Hanover (West Germany)). 15p.

The optimum layout of a power plant is characterized by that ratio of heat consumption to construction cost which ensures the cheapest production of the kWhr. The effects of the chosen circuit data on the thermal efficiency are examined, and the construction cost of reactor, turbine, compressor, and heat exchanger are used to point out the most important interrelations between these factors. (auth)

34092 (EUR-2757.e, pp 195-) POSSIBILITY OF USING GAS BEARINGS IN A LARGE SCALE POWER GAS TURBINE ASSOCIATED WITH A NUCLEAR REACTOR. Poulain, Jean; Mech, Christian (and others) (Societe Rateau, La Courneuve (France)). 26p.

A gas turbine for use with a 250 MW reactor is described. The turbomachinery design and rotating assembly design of a turbocompressor unit are detailed. The design of a turbocompressor thrust bearing is given. (M.L.S.)

34093 (EUR-2757.e, pp 217-) TENTATIVE LAYOUT OF AN HTGC REACTOR WITH A GAS TURBINE CYCLE. Lockett, G. E. (European Nuclear Energy Agency, Paris (France)). 9p.

A design concept for a high temperature gas-cooled reactor with gas turbine cycle is presented. A reduction of building space and engineering effort is achieved by the design. A brief discussion of steam cycle economics is given. (M.L.S.)

34094 (EUR-2757.e, pp 229-) TURBOMACHINERY. Holliday, J. B.; Keenan, J. G. (Rolls-Royce Ltd., Derby (England)). 29p.

A feasibility study of the use of turbomachinery to reduce capital costs in nuclear power stations is presented. The flow cycle is discussed; various components of the system are discussed individually. (M.L.S.)

34095 (EUR-2757.e, pp 261-) MATERIALS IN A DIRECT CLOSED CYCLE GAS TURBINE APPLICATION OF THE HIGH TEMPERATURE GAS COOLED REACTOR. Conde, J. F. G. (European Nuclear Energy Agency, Paris (France)). 41p.

In considering materials for a gas turbine application of the HTGC reactor it is necessary to assess the extent to which use can be made of established materials and the problems which may be encountered in their application. The parameters of a direct cycle HTGC system are described briefly with particular reference to temperature levels. Materials for conventional gas turbine plant are discussed and the characteristics required for operation in the several areas of the gas turbine are indicated. The chemical composition of available gas turbine alloys and their mechanical, physical, corrosion resistance, and other relevant properties are described and metallurgical stability and fabrication aspects are discussed briefly. The properties of materials relevant to service in the HTGC reactor environment are discussed with particular reference to compatibility with trace impurities which may be present in the He. The results of compatibility experiments carried out for the Dragon and Peach Bottom HT reactors are indicated and the behavior of materials is discussed. It is concluded that existing evidence indicates the need for protective coatings if conventional high temperature materials or refractory Mo or Nb alloys are to be employed. The main area requiring research and development appears to be the turbine blading where development of adequate coatings or of alternative materials having specific compatibility with the environment may be required. Economic aspects and design criteria are touched upon briefly. Alternative materials are discussed and it is concluded that there is no lack of materials potentially capable of operating at even higher temperatures than those considered at present although development work will be required. (auth)

34096 (EUR-2757.e, pp 305-) METALS IN DIRECT CYCLE HTR-GAS TURBINE CIRCUITS. Pugh, S. F.; Antill, J. E. (Atomic Energy Research Establishment, Harwell (England)). 19p. (AERE-R-4927).

An account is given of the possible modes of failure of metals and alloys in the HTR coolant on exposure for long times at high temperatures. The chemical nature of the coolant is such that Ni and possibly Fe may be unattacked. Alloys of these two metals containing elements which form stable oxides or carbides such

as Cr, Ti, or Al may be of little or no use. In particular, alloys containing Cr may be susceptible to volatilization of Cr, oxidation and carburization. Conventional heat resisting alloys are only considered applicable for components which can be cooled well below 750°C. For temperatures in the region of 750°C unalloyed Ni, Fe, or Ni dispersion strengthened with ThO_2 may be the most suitable material. For higher temperatures the refractory metals have been considered but their use would result in severe compatibility problems with the coolant. If components are to be used at or above 750°C it is clear that work specifically directed at the HTR application will have to be undertaken on the development of alloys with stable structures and on the compatibility of these alloys with the HTR coolant. (auth)

34097 (EUR-2757.e, pp 331-) HIGH TEMPERATURE CONSTRUCTION ELEMENTS FOR GAS TURBINES. Seippel, C. (Brown, Boveri and Co., Ltd., Baden (Switzerland)). 20p.

The advantages and disadvantages of the use of gas turbine cycles for high temperature gas cooled reactors is discussed. Safety and continuity of operation are considered. The economics of using gas turbines is briefly discussed. (M.L.S.)

34098 (EUR-2757.e, pp 353-) APPLICATIONS OF CLOSED GAS TURBINE CYCLES WITH A PEBBLE BED HTGCR. Brehm, E. A.; Ermisch, K.; Friederich, B.; Gerold, K.; Maring, B.; Schmiedel, F.; Schafstall, H. G.; Wladarz, M. (Brown Boveri/Krupp Reaktorbau G.m.b.H., Mannheim (West Germany)). 30p.

The use of closed gas turbine cycles with a pebble-bed gas-cooled reactor is considered. A design for a compact single cycle plant is given. The results of experimental investigations into turbine design, use of high gas pressures and temperatures, and turbine fabrication are discussed. The economics of gas turbine in nuclear power plants is briefly outlined. (M.L.S.)

34099 (EUR-2757.e, pp 423-) CORE DESIGN FOR HELIUM AND ARGON COOLED GAS TURBINE POWER REACTORS. Marien, P. (European Nuclear Energy Agency, Paris (France)). 12p.

A design concept is presented for a core design for a reactor with fuel materials in direct contact with the coolant. Coolant materials considered are He and Ar. The design parameters are tabulated. (M.L.S.)

34100 (EUR-3471.i) SVILUPPO DELLA TECNICA DI FABBRICAZIONE DI ELEMENTI DI COMBUSTIBILE IN LEGHE DI URANIO. RELAZIONE FINALE. (Development of Uranium-Alloy Fuel-Element Fabrication Process. Final Report). Dalmastri, B.; Fizzotti, C. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari). May 1967. 98p. (In Italian). Dep.

A study was carried out on the design and fabrication of fuel elements of the type currently used in the Latina Power Plant. In particular, the study envisages the fabrication of elements containing rods of fuel made up of a ternary U–Mo–Nb and U–Mo–Zr alloy which has been subjected to special heat-treatment. The entire work can be broken down into three quite distinct phases—rod fusion, heat-treatments, and element assembly and cladding. Each of these operations in turn comprises a series of special processes which have necessitated the development of methods and equipment, in some cases appropriately designed, which are described in detail. (auth)

34101 (EUR-C-2500-67e) SENA [REACTOR PROJECT] QUARTERLY REPORT NO. 19, JANUARY 1–MARCH 31, 1967. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). Apr. 28, 1967. 9p. Dep. CFSTI.

Summaries are presented on design studies, prefabricated components, on-site work and testing at the Ardennes Nuclear Power Plant. The neutron shield is being redesigned. (J.C.W.)

34102 (EURAEC-1786) STABILITY EXPERIMENTS FOR BOILING WATER REACTORS. Quarterly Report No. 8, October 1–December 31, 1966. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany). Kernenergieanlagen). Contract 085-66-1TEED. 41p. (EUR-3328). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Relations describing frequency behavior during the transfer of heat produced uniformly in the heating tube to the coolant flow past it were derived from the Fourier heat transfer equation and included in the AMOK-L formula plan. For the special case of cylindrical geometry, the heat output—heat per surface unit frequency characteristic was calculated as a function of various heat transfer coefficients and given as a table or diagram. This also made it possible to convert the experimentally-determined heat output—local vapor bubble fraction frequency characteristic curves to the heat per surface unit—local vapor bubble fraction characteristics which are of more general validity since they are independent of geometry and material. Theoretical and experimental results are compared, and the results discussed, using a measurement series. The test facility with the new square measurement section, four-rod cluster and velocity moderator was brought into service. Intensive work was done on the optimization and improvement of the automatic control system and moderator functioning, changes in the semi-ductor turning out to be especially necessary. (auth)

34103 (EURAEC-1789) STUDY OF A PRESTRESSED CONCRETE VESSEL FOR A BOILING-WATER REACTOR OF 1000 MWe. Final Report. (Societe d'Etudes et d'Equipments d'Entreprises, Paris (France)). Sept. 1966. Contract 068-65-7-TEEF. 262p. (EUR-3331). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Definition of the hypotheses and the calculation methods of the structure, study of the stresses, dimensioning of the vessel, study of the prestress, dimensioning of the cooling circuit and metal parts, and the study of the overall cost are presented in the preliminary reports. The reference project of the model has been designed. Studies on the heat insulator have continued, but the results are not completed. (J.C.W.)

34104 (GA-7097) PRESTRESSED CONCRETE REACTOR VESSEL MODEL 1. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 25, 1966. Contract AT(04-3)-167. 391p. Dep. CFSTI.

Details of construction and testing of a prestressed concrete reactor pressure vessel model are reported. Topics discussed include design, specifications for construction materials, fabrication, instrumentation, test equipment and techniques, and results of observations. Diagrams are presented to show compressive and tensile stresses and construction at various stages of progress is shown in photographs. The tests performed indicate that the model is capable of withstanding an overpressure of more than $3\frac{1}{2}$ times the normal working pressure without structural failure. (P.G.C.)

34105 (GA-7150) PRESTRESSED CONCRETE REACTOR VESSEL MODEL 2. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 4, 1966. Contract AT(04-3)-633. 350p. Dep. CFSTI.

Development of technology associated with prestressed concrete reactor vessels (PCRV) is reported. A description is included concerning construction, prestressing, and pressure testing of PCRV model 2. (J.R.D.)

34106 (GA-7941) THERMAL DESIGN ASPECTS OF GAS-COOLED REACTOR CORES. Katz, Robert (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 19, 1967. Contract AT(04-3)-187. 44p. (CONF-670530-1). Dep. CFSTI.

From 4th Annual Technical Symposium of the American Society of Mechanical Engineers, Idaho Falls, Idaho.

Reactor core thermal design includes pumping power requirements and temperature criteria. Selected reactors are reviewed and design core temperature criteria identified. Main design parameters available for reducing pumping are discussed. Heat transfer characteristics needed for design evaluation are illustrated and special heat transfer problems are given. (J.C.W.)

34107 (GA-7988) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR POSTCONSTRUCTION RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending April 30, 1967. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). May 24, 1967. Contract AT(04-3)-314. 98p. Dep. CFSTI.

The operation of the Peach Bottom Reactor is summarized for January. The reactor was shut down during February while modifications and repairs were made. After modifications and repairs were completed, a warmup was begun using compressor heating. Flow calibration tests were performed over the full range of design flows using U-tube manometers to improve heat balance calculations. Power was raised and power calibration work begun. Dynamic testing was performed at 30% power and a scram performed. Testing continued at increased power and at 60% power a hot spot appeared on the bottom head of the steam generators. A dump valve failed and the reactor was shut down for repairs. A maximum power of 68 MW(t) was reached yielding 25 MW(e) gross output, for a total energy of 6500 MW-hr(t) and 2000 MW-hr(e). (J.C.W.)

34108 (GEAP-5198) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 19, May–July 1966. (General Electric Co., San Jose, Calif. Advanced Products Operation). Aug. 1966. Contract AT-(04-3)-189. 95p. Dep. CFSTI.

A program is being conducted to develop fast ractors using ceramic fuels, in particular mixed PuO_2–UO_2. Progress is reported for tasks concerning vented fuel development, transient testing of fuels, fuel performance, fast flux irradiation of fuel,

reactor physics and core analysis, and FCR cladding evaluation. (J.C.W.)

34109 (GEAP–5292) SODIUM COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 20, August–October 1966. (General Electric Co., San Jose, Calif. Advanced Products Operation). Nov. 1966. Contract AT(04-3)-189. 109p. Dep. CFSTI.

A program to develop fast reactors using ceramic fuels, particularly mixed PuO_2-UO_2, is in progress. Tasks reported concerning vented fuel development, transient testing of fuels, fuel performance, fast flux irradiation of fuel, reactor physics and core analysis, and FCR cladding evaluation are summarized. (J.C.W.)

34110 (GEAP-5498) "COUGAR": A SIMPLIFIED COMPUTER CODE FOR CALCULATION OF OPERATIONAL THERMAL–HYDRAULIC PARAMETERS FOR EVESR. Cook, K. W. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Feb. 1967. Contract AT(04-3)-189. 76p. Dep. CFSTI.

A COUGAR Computer Code is described that was developed to determine the thermal-hydraulic operating parameters for two-pass, cluster type, superheat fuel elements in EVESR. This code determines cladding and steam temperatures in the active fuel region, as well as pressure and heat losses from the saturated steam inlet to the superheat steam outlet at the vessel wall where steam conditions are measured and controlled. The code was written to allow incorporation of actual plant data and experimental results into the heat loss and pressure drop correlations. This code offers an example of the practical application of computerized thermal-hydraulic techniques to an operating test reactor. (auth)

34111 (IDO–17227) TOODEE: A TWO-DIMENSIONAL, TIME-DEPENDENT HEAT CONDUCTION PROGRAM. McClure, John A. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1967. Contract AT(10-1)-205. 167p. Dep. CFSTI.

TOODEE is a two-dimensional, time-dependent heat conduction computer program written in the FORTRAN IV and MAP languages. This program is suitable for investigating general transient and/or steady-state problems. Typical of (but not limited to) the types of problems for which the program has been used are the calculation of temperature distributions in reactor fuel elements during power excursions. The mesh for the program is formed by variably spaced orthogonal curves in either slab or cylindrical geometry. The cylindrical geometry may be either axisymmetric, with space variables R-Z, or polar, with space variables R-θ. Conditions to be specified independently at each boundary are either surface temperatures or heat transfer coefficients and either exterior temperatures or flow rates. Materials and coolant properties required in the program are evaluated from FORTRAN arithmetic functions supplied by the user. These properties may be time and/or temperature dependent. In addition, nonisotropic thermal conductivities and expansion coefficients may be defined. Phase changes are permitted in all materials except coolants. (auth)

34112 (KAPL-P-3344) MONTE CARLO CRITICALITY CALCULATIONS FOR THERMAL REACTORS. Mendelson, M. R. (Knolls Atomic Power Lab., Schenectady, N. Y.). [nd]. Contract W-31-109-eng-52. 16p. (CONF-670602-20). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

A development of the Monte Carlo code for criticality calculations for thermal reactors is discussed. The results of the application of the Monte Carlo method for computing thermal reactor eigenvalues are tabulated. Characteristic data from a typical computer run are shown graphically. (M.L.S.)

34113 (NAA-SR-Memo-4479) OBSERVATIONS OF CARBON IN SRE SODIUM. Hinze, R. B. (Atomics International, Canoga Park, Calif.). Oct. 12, 1959. 32p. Dep. CFSTI.

Fine C particles resulting from the decomposition of hydrocarbons in the Na deposited on the walls of cold (440°F) Na piping in the SRE secondary cooling system, where they decreased the ability of the Na to wet the pipe wall. This change in wetting explains the decrease in flow indication observed on EM flowmeters after the introduction of tetralin into a system. The form and properties of the carbonaceous material found in SRE Na was determined. Certain effects observed in the reactor are explained and methods for the removal of carbon are developed. (J.C.W.)

34114 (NAA-SR-Memo-12394) SODIUM PURITY REQUIREMENTS (A REVIEW AND EVALUATION). Hinze, R. B. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). May 10, 1967. Contract AT(04-3)-700. 57p. Dep. CFSTI.

Impurities in Na coolant used in a Fast Breeder Reactor are identified and their significance discussed. Na purity requirements are developed for a coolant system constructed of austenitic-stainless steel and 2-¼ Cr-1 Mo ferritic steel, operating at a 1200°F reactor outlet temperature for 30 years. The report concludes that a 2-ppm limit on O_2 concentration is necessary for acceptable corrosion (2 mil) during 3-year life of fuel-element cladding when cladding temperature is 1300°F. Use of a gettering device is indicated to achieve this low O_2 concentration. Recommendations are presented for additional work needed to strengthen the basis for these purity requirements. (auth)

34115 (ORNL–4073) UNDERWATER CAISSON CONTAINMENT OF LARGE POWER REACTORS. Klepper, O. H.; Bell, C. G. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 269p. Dep. CFSTI.

The results of an investigation on the feasibility and potential advantages of containing large nuclear power reactors in underwater caissons are presented. The reference design described consists of a 715-Mwe boiling-water reactor housed in a concrete caisson located one-half mile offshore. The turbine-generator is located on a ten-acre artificial island, which surrounds the caisson. Seawater is employed for containment cooling and to reduce the outleakage of fission products in the event of a reactor loss-of-coolant accident. It is estimated that the activity release rates to the environment would be several orders of magnitude smaller than for the corresponding aboveground containment system. Significant contamination of the sea appears unlikely. For an unprotected ocean site, island caisson containment increases plant capital costs by about $7,000,000. It is suggested that this new containment approach be considered for power reactors near metropolitan areas that require augmented reactor safety and that are adjacent to a suitable lake, river, or ocean. (auth)

34116 (WCAP–6077) DIFFUSION-THEORY DEPLETION ANALYSIS OF THE YANKEE CORE. Lacey, P. G.; Radcliffe, R. E. (Westinghouse Electric Corp., Pittsburgh, Pa. Bettis Atomic Power Div.). [1966]. Contract AT(30-1)-3017. 124p. Dep. CFSTI.

A multi-dimensional, diffusion-theory depletion analysis of the Yankee core is presented, with particular emphasis on calculation of the change in isotopic fuel content in Yankee Core I, and the variation in core reactivity and nuclear hot channel factors with life. A single-channel flux-synthesis approach is used consisting of two-dimensional (x-y) depletion calculations coupled with one-dimensional (axial) flux-synthesis calculations. As a test of the analytical methods, depletion calculation results are compared with measurements obtained through destructive examination of the first Yankee core. The comparison includes Core I fuel which had been recycled in Core II for extended burnup, in addition to fuel which had undergone normal burnup during Core I lifetime. (auth)

34117 RESEARCH IN FUEL ELEMENT DESIGN. Anastasijevic, Predrag (Boris Kidric Inst. for Nuclear Sciences, Belgrade); Ristic, Momcilo; Kolar, Drago. Nukl. Energ., 4: No. 1, 1-4(1967). (In Slovak).

Current research leading to the production of fuel elements for nuclear power plants in Yugoslavia in the years to come is described. Initial results have been achieved in the mastering of all the stages in fuel element production. Study of conditions for the sintering of domestic made UO_2 powder provides a basis for the elaboration of the technology of the sintered pellet production. For the nuclear-physical, hydro- and thermodynamic investigations a prototype of a fuel element assembly has been prepared, using imported Zircaloy-2 for coating. The necessary technological and chemical analyses have been completed, as well as preparations for the study of radiation damage and corrosion of components to be used for the production of fuel elements in Yugoslavia. (auth)

34118 OPERATING EXPERIENCE WITH THE SWEDISH AGESTA NUCLEAR POWER STATION. Callsen, K. H. (Siemens-Schuckertwerke AG, Erlangen, Ger.). Atomwirt., Atomtech., 12: 244-6(May 1967). (In German).

A history of the 2½ years of full power operations of Agesta is given. The approach-to-power tests are described. Physics parameters of the system are tabulated. (M.L.S.)

34119 DETERMINATION OF CORE BURNUP, ISOTOPIC INVENTORY, AND CONVERSION RATIO FROM SELECTIVE SAMPLING OF SPENT REACTOR FUEL. Jedruch, J.; Nodvik, R. J. (Westinghouse Atomic Power Div., Pittsburgh). Contract AT(30-1)-3017. Nucl. Appl., 3: 507-18(Aug. 1967).

The determination of the isotopic composition and the fission-product inventories of a spent reactor core are demonstrated through the proper selection of sampling points and analytical treatment of data using Core I of the Yankee reactor as an example. This core is found to contain 172 kg of ^{235}U less than initially loaded, plus 97.0 kg of freshly generated Pu. Mass balances of U and Pu isotopes and the fission products are used to demonstrate the various possible ways of defining the end-of-life con-

version ratio, with the preferred definition giving a value of 0.50 for the Yankee core. Methods of determining the total burnup from U and Pu concentrations, from ^{137}Cs activity, and from plant calorimetrics are discussed and applied to the Yankee data and give 8.40 ± 0.21 GWD/MTU for the core average burnup. (auth)

34120 REACTOR COOLING WITH ALKALI METALS. Laue, H. J. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech., 12: 258(May 1967). (In German).

The Symposium was concerned with alkali metal coolants and, in particular, with corrosion investigations on reactor materials exposed to liquid Na and with operating experience with Na components. Although the German Federal Republic has attained equal status with other countries in the general development of fast breeder reactors its experience with Na corrosion and component behavior is still limited. First experience is coming from experiments in the Interatom experimental plant and important contributions will be made by the KNK reactor now under construction in Karlsruhe. (auth)

34121 FURTHER DEVELOPMENT OF LIGHT-WATER REACTORS IN EUROPE. Hundt, D. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). Atomwirt., Atomtech., 12: 256-7(May 1967). (In German).

A summary of a European meeting on the further development of light water reactors is reported. It was concluded that the further development, though possible and useful, must be funded by either the governments or Euratom if Europe is to maintain the American pace. (M.L.S.)

34122 EXPERIENCE WITH CONVENTIONAL AND PARA-NUCLEAR PARTS OF NUCLEAR POWER STATIONS. Atomwirt., Atomtech., 12: 255-6(May 1967). (In German).

Contrary to all original expectations it has been shown in the building and operation of nuclear power stations that delays in the construction of plant and interruptions in operation are predominantly due to difficulties with conventional and paranuclear installation parts. The causes lie mostly in design errors and constructional failings and seldom in improper operation. The most important conclusion arising from the Euratom Symposium on the 17th and 18th November 1966 was therefore that the quality controls usual in the building of conventional installations are often not adequate for nuclear power plants. (auth)

34123 DUNGENESS B Nucl. Eng., 12: 524-38(July 1967).

A survey is presented under the following headings: Advanced gas-cooled reactor power station; Safety aspects; Overall station control; Fuel handling; Reactor core design; Research and development. (UK)

34124 TREAT MELTDOWN OF IRRADIATED METALLIC FAST-REACTOR FUEL IN AN INERT ATMOSPHERE. Dickerman, C. E.; Robinson, L. E.; Sowa, E. S.; Monaweck, J. H.; August, C. (Argonne National Lab., Ill.). Nucl. Appl., 3: 461-73(Aug. 1967).

Behavior of two types of irradiated metallic fast-reactor fuel pins under transient heating in an inert-gas atmosphere in the TREAT reactor was studied under conditions ranging up to complete meltdown. Irradiation-induced changes in failure thresholds, modes of failure, and post-failure fuel motion were significant but not enough to make gross changes in the course of an accident. The amount of swelling observed in the post-experimental fuel residue was large enough to have played a significant role in determining the course of a meltdown accident. (auth)

34125 COMPENSATION OF THE REACTIVITY OF NUCLEAR REACTORS BY MEANS OF LAMINAR BURNABLE POISON. Artamkin, V. N.; Voronkov, A. V. At. Energ. (USSR), 22: 215-18 (Mar. 1967). (In Russian).

The possibility of using laminar burnable poisons for the compensation of the reactivity of nuclear reactors was examined. A method was proposed making it possible in the P_1 approximation of neutron distribution outside the absorbers and in the absence of scattering to calculate the spatial-time distribution of the poisons in the flat burning poisons composed of several layers of heterogeneous materials. (tr-auth)

34126 CONTRIBUTION TO THE DESIGN PARAMETERS OF POWER STATION WITH REACTOR DOR. Kujal, Josef; Mantlik, Frantisek (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jad. Energ., 13: 201-5(June 1967). (In Czech).

The description of a complex physical-thermokinetic program for determination of the main parameters of heavy water reactor power station with ceramic fuel and organic coolant is given. The physical and thermokinetic problems are discussed separately with descriptions of main mutual relations. In conclusion, some results are presented. (auth)

34127 THE USE OF STATISTICAL METHODS IN THE DETERMINATION OF REACTOR DYNAMICS. Larssen, B. (NORATOM AS, Oslo). Neue Tech., 9: 141-5(May 1967).

The terminology used in statistical analysis of reactor systems is discussed. Random signals are analyzed in the amplitude, frequency, and time domain. An instrument for computation of amplitude distribution functions, power spectral density, and correlation functions is briefly discussed. (M.L.S.)

34128 DESIGN AND PERFORMANCE OF CONTROL SYSTEMS FOR CANADIAN NATURAL URANIUM REACTORS. Holt, J. O.; Davis, G. T. (Canadian General Electric Co., Peterborough, Ont.). Neue Tech., 9: 133-41(May 1967).

The design of the reactor power regulating and protective systems of two Canadian heavy-water-moderated reactors is described briefly. The close association between designers and station operators has made it possible to review operating experience and compare it with that predicted. The effect of this experience on present and future designs is discussed. (auth)

34129 ON THE PROGRAM OF NEUTRON PHYSICS OF THE EDF-2 AND EDF-3 CENTRAL POWER STATIONS. Baude, M. (Compagnie des Compteurs, Montrouge, France); Baude; Billat; Bonnemort. Neue Tech., 9: 152-60(May 1967). (In French).

In the atomic power plants EDF-2 and EDF-3 a reference input generator indicating the desired value of the nuclear reactor output in the form of analog signals is needed during certain operation periods. The working principle of this device is described in detail. (auth)

34130 STABILITY ANALYSIS OF REACTOR SYSTEMS VIA LYAPUNOV'S SECOND METHOD. Hsu, C. (Argonne National Lab., Ill.). J. Basic Eng., 89: 307-10(June 1967).

A technique for finding Lyapunov functions for the class of nonlinear partial differential equations arising from a reactor system which takes into account the coupling of heat transfer, hydrodynamics, and time-dependent neutron diffusion is given. As a first step, a generalized Lyapunov function is developed for the linearized reactor system. The result provides the sufficient conditions to system stability (and/or asymptotical stability) with respect to the distributed system parameters. A new Lyapunov function for the nonlinear reactor system is constructed by adding nonlinear terms to that of the linear system. The result enables one to determine the region of stability and indicates the proper feedback function which would ensure the global stability of the system. (auth)

34131 DISTRIBUTED PARAMETER OPTIMUM CONTROL OF A NUCLEAR ROCKET WITH THERMAL STRESS CONSTRAINTS. Briggs, D. L.; Shen, C. N. (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Basic Eng., 89: 300-6(June 1967).

Control of coolant flow-rate through a nuclear rocket is considered. Temperature gradients in the fuel elements, and the correspondingly produced thermal stresses, are analyzed. The system equations are a pair of coupled, first-order, bilinear, partial differential equations which describe the steady-state. Analysis of the solution for a step in control and the coupling between control level and time response gives the needed form of optimal control. Use of the digital computer in generation of the optimal control law is discussed. Numerical results are given. (M.L.S.)

34132 STABILITY OF COUPLED-CORE NUCLEAR REACTORS: SELECTED EXACT RESULTS. Gage, S. J. (Univ. of Texas, Austin); Adler, F. T. J. Basic Eng., 89: 283-6 (June 1967).

Exact analytical stability criteria are derived for the coupled-core kinetics equations. Four approximate models for describing the time distribution of the coupling neutrons are considered and a theorem proved by Pontryagin is used to establish the asymptotic stability of the systems. The criterion based on the Single Delta Function Model is compared with the one based on the Single Step Function Model. (auth)

34133 CALCULATION OF THERMAL-GROUP CONSTANTS IN THREE-REGION LATTICES. Stamm'ler, Rudi J. J.; Tas, Aldert (Reactor Centrum Nederland, Petten, Netherlands). Nukleonik, 10: 33-41(June 1967).

Three types of calculations for obtaining thermal-group constants are considered. The discussion is confined to the familiar three-region cells consisting of fuel rod-clad-moderator. One of the methods is of the THERMOS type, represented by K-7 THERMOS AND MICROFLUX, which are known to give reliable results. For the purpose of design calculations, accuracy is usually sacrificed for time. Two examples of fast design methods are given, namely, DATAPREP II and SATAN. It is shown that in the former the demands for accuracy have been slackened too much while the latter method produces thermal-group constants that compare favourably with THERMOS results. (auth)

34134 RAMP REACTOR EXCURSIONS WITH NONLINEAR FEEDBACK. Canosa, Jose (General Electric Co., Pleasanton, Calif.). Nukleonik, 10: 41-5(June 1967).

The problem of reactor excursions caused by a ramp reactivity insertion is solved by approximate analytical methods in the prompt approximation, when the reactor has a very general temperature-dependent reactivity feedback. (auth)

34135 MEASUREMENTS AND ANALYSIS OF REACTIVITY EFFECTS IN EMPTY CHANNELS IN A FAST REACTOR. Tiren, Lars Ingmar (Aktiebolaget Atomenergi, Studsvik, Sweden). Nukleonik, 10: 14-18(June 1967).

Measurements of neutron streaming in empty channels and interaction between channels have been made in the zero energy fast reactor FR-0. Calculations of the measured effects have been performed using diffusion theory with streaming-corrected diffusion constants. While exact agreement with experiment has not been achieved, the calculated values qualitatively reproduce the experimental results. The observed streaming effects are large enough to warrant consideration in current measurements of coolant-void reactivities performed in fast zero energy reactors. (auth)

34136 THREEFOLD CORRELATIONS AND THIRD ORDER MOMENTS IN REACTOR NOISE. Dragt, J. B. (Reactor Centrum Nederland, Petten, Netherlands). Nukleonik, 10: 7-13(June 1967).

A theory is presented for the evaluation of third order moments of neutron counts in a reactor due to threefold correlation of the detected neutrons. Point reactor theory is used throughout. The probability for detection of three neutrons in succession is found, and from that the central moments of the numbers of neutron counts in specified time intervals are calculated, as well as the triple autocorrelation function for the count rate. The threefold correlations are shown to be due to two different branching processes in the fission chains in the reactor. In the dominating and easily measurable process only splitting of the fission chains into two branches is detected. A variant of the Feynman-α-technique is proposed for the measurement of this effect. In the other process triple splitting of the fission chain is involved. This process can provide new physical information; in particular, reactor power and effective delayed neutron fraction can be obtained without the need for any other static measurement. An experiment for the measurement of this effect is proposed, which is shown to be most feasible for a fast reactor. (auth)

34137 GEOMETRY OF THE IDEAL FIXED BED. Wierusz, A. (Inst. of Nuclear Research, Warsaw). Nucl. Eng. Design, 5: 338-48(May 1967).

The main geometrical factors of fixed beds with regular and rhombohedral lattices formed by identical spheres contained in a cylindrical vessel are discussed. The expressions for the number of spheres in the bed, the constriction and the void coefficients for the bed as functions of the vessel's dimensionless diameter are given. Some results of the calculations performed on the digital computer for dimensionless diameters from 3 to 1000 are presented. The results may serve as a basis for nuclear, thermal and mechanical analysis of reactor cores consisting of spherical fuel elements. (auth)

34138 SECOND-ORDER EFFECTS AS RELATED TO CRITICAL COOLANT FLOW VELOCITIES AND REACTOR PARALLEL PLATE FUEL ASSEMBLIES. Wambsganss, M. W. Jr. (Argonne National Lab., Ill.). Nucl. Eng. Design, 5: 268-76(May 1967).

Second-order effects are retained in a stability analysis of the equation of motion of a flat fuel plate in a reactor parallel plate fuel assembly. The second-order terms generate an additional stability criterion in the form of an upper bound (critical deflection) on the amplitude of quasi-static deflections for stable oscillations, or neutral stability, about the undeflected fuel plate position. The critical flow velocities are upper bounds to ensure local stability about the undeflected plate position. A constant of proportionality, relating the critical deflection to the initial channel depth, is designated as a design constant. When assigned a value, the design constant defines new critical coolant flow velocities. (auth)

34139 THE DESIGN AND DEVELOPMENT OF THE HEAVY WATER ORGANIC COOLED REACTOR (HWOCR) PRESSURE TUBE ASSEMBLY. Oslick, H.; Museler, W. J.; Selig, B. J. (Combustion Engineering Inc., Windsor, Conn.). Contract AT(38-1)-430. Nucl. Eng. Design, 5: 285-94(May 1967).

The heart of the Heavy Water Organic Cooled Reactor (HWOCR) system is the pressure tube assembly which forms the primary coolant channel and houses the nuclear fuel. Its design permits on-power refueling. The in-core portion of the pressure tubes is fabricated from SAP, a neutron-capture cross section material which is compatible with the organic coolant. A modular approach is used for the pressure tube assembly design. Major areas of design and development such as in-core pressure tube section, transition joint, end fitting assembly, shield plugs, pressure tube extensions, pressure tube assembly, and fabrication are described. (auth)

34140 THE BEHAVIOUR OF THE OLDBURY NO. 1 REACTOR PRESSURE VESSEL DURING PRESTRESSING AND PROOF PRESSURE TEST. Eadie, D. McD. (Nuclear Power Group, Ltd., Cheshire, Eng.). Nucl. Eng. Design, 5: 295-310(May 1967).

The prestressing of the Oldbury No. 1 reactor pressure vessel, the checks on tendon anchorage loads, and the readings taken from the strain gages within the concrete are described. The readings are compared with theoretically predicted results based on computer analysis in combination with the measured tendon anchorage loads and assumed values for Young's modulus, Poisson's ratio and specific creep time functions. From this comparison reasonable values are obtained for instantaneous E values and specific creep time functions appertaining to the Oldbury vessels at ambient temperature. The proof pressure test is described and the various readings obtained are compared with anticipated values. (auth)

34141 INVENTORY OF FISSION PRODUCTS OF INTEREST IN THE EVALUATION OF NUCLEAR RISKS. Santos, Agustin Alonso; Crespo, Manuel Dominguez. Energ. Nucl. (Madrid), 10: 485-95(Nov.-Dec. 1966). (In Spanish).

Equations are derived to represent the inventory of fission products in the event of a critical incident. The equations are evaluated and the results are graphed. (J.S.R.)

34142 SPANISH NUCLEAR LEGISLATION. Lasurtegui, Alfonso de los Santos. Energ. Nucl. (Madrid), 10: 509-18 (Nov.-Dec. 1966). (In Spanish).

A brief chronological review is given of the enactments promulgated in Spain with respect to nuclear energy. (J.S.R.)

34143 INVESTIGATION OF NUCLEAR REACTOR THREE DIMENSIONAL TEMPERATURE FIELD BY MEANS OF AN ANALOGUE TECHNIQUE. Gribanov, Yu. I.; Minashin, V. E.; Sholokhov, A. A. At. Energ. (USSR), 22: 276-9(Apr. 1967). (In Russian).

The method for the calculation of the temperature in nuclear reactors by means of analogue simulation was examined. The change of the heat generation according to the height of the reactor and in cross sections was taken into consideration in the solution. For calculation of the change of the heat generation with respect to the height of the reactor two methods were proposed: directly by means of the change with time of the density of the input current of the analogue simulation, and a method of calculation by means of Dyuamel integrals. For the latter case the investigation of the temperature field was made with heat generation constant up through the reactor and the results obtained were converted by means of Dyuamel integrals to any regularity of the change of the heat generation through the reactor. (tr-auth)

34144 THE USE OF NUCLEAR FUELS AT THE CHINON POWER STATION. Tanguy, M.; Faure, M. Energ. Nucl. (Paris), 9: 163-72(May 1967). (In French).

Progress in the production of electricity by industrial scale nuclear power stations has caused producers of electricity a certain number of technical problems such as the use of fuels and fuel elements as well as the use of a nuclear reactor as a generator. These problems are studied in the light of the experience acquired at the Chinon Power Station through E.D.F.I, II and III. The Chinon reactors, in spite of their industrial use, have an experimental aspect which permits radiations of standard and non-standard elements as well as experimental elements which sometimes cause trouble. These experiments can be justified because of the future development, in France, of the gas-graphite line of the next nuclear power stations of the Fifth Plan. (auth)

34145 INDUSTRIAL ASPECTS OF A FAST BREEDER REACTOR PROGRAMME. THIRD FORATOM CONGRESS, LONDON, APRIL 24 TO 26, 1967. INTERNATIONAL REPORTS. London, British Nuclear Forum. 48p.

The following subjects are discussed at the 3rd Foratom Congress: fast reactor development objectives, general reactor characteristics, and fuel requirements; fuel fabrication and reprocessing; European fast reactor experimental programmes and further development; prototype designs; Thorium–U 233 reactors; European fast reactor programmes and economics. (UK)

Marine and Portable Power Reactors

Refer also to abstracts 32951 and 34064.

34146 (EUR-2757.e, pp 385-) NUCLEAR GAS TURBINES FOR MARINE APPLICATION. Boehm, E. (Gutehoffnungshuette Sterkrade A.G., Oberhausen (West Germany)). 26p.

The use of a closed cycle gas turbines in connection with high temperature reactors for ship propulsion has many advantages as compared with double circuit systems with steam turbines. The expensive steam generator is abolished, whereby the investment costs and weights are lower and an improvement of efficiency is achieved. Even for the ship propulsion unit with an output of between 20,000 and 30,000 shp an efficiency of over 30% is obtained. Owing to the fact that the load alteration with admission control is a feature restricted only to the closed cycle gas turbines the degree of efficiency remains very high within wide load ranges. The high load change speeds permit good maneuverability of the ship. The viewpoints are considered which arise by the combination of a gas turbine and a high temperature reactor to a ship's propulsion unit. The example shown deals with the layout of a unit of ~30,000 shp. The installation of this nuclear propulsion unit in a tanker with a carrying capacity of ~90,000 tdw is described. This proves that the space requirement of the nuclear plant is approximately in accordance with a classic plant. (auth)

34147 (NUS-339) ECONOMICS OF NUCLEAR PROPULSION FOR MARITIME APPLICATIONS. (Nuclear Utility Services, Inc., Washington, D. C.). Feb. 1967. 56p.

Detailed data on the direct capital costs, installation costs, schedules, scopes of supply, fuel costs, and refueling costs of currently offered pressurized water reactors for maritime applications are evaluated. These reactors could be installed as the steam generators for ship propulsion plants with commercial operations. Total ship costs and the total differentials between nuclear and conventional propulsion are not identified. Certain of the plants proposed can be committed directly to commercial ship applications with reasonable uncertainties and risks. Nuclear ship construction will be strongly influenced by the lead times involved in design, fabrication and installation of the reactor. Accordingly, the first nuclear ship construction spans will be about four years. Fuel performance projections appear reasonable. Based on the designs proposed, initial core lifetimes of four to five years, at an annual plant load factor of 70%, should be achievable. Three to four refuelings will be required over the 25-year economic lifetime of a nuclear ship on the basis of the reactor designs proposed. These refuelings will take, on the average, about 21 days to accomplish. Although the results of these studies lend credence to certain previous projections of maritime reactors' capital fuel and refueling costs, they are highly dependent on careful management planning. (auth)

34148 THE OTTO HAHN, THE NUCLEAR POWER RESEARCH SHIP AND ITS IMPORTANCE FOR THE EUROPEAN COMMUNITY. Rojahn, Wolfgang; Jacquot, Andre. Energ. Nucl. (Paris), 9: 173-80(May 1967). (In French).

The major participation of Euratom in the development of reactors designed for the merchant navy is described, as well as the fields of research and how the research is carried out within the European framework. The nuclear ore-ship, Otto Hahn, designed for experimental research is fully described. As for the future, it is indicated, as a data example, that another rival ship will be built with a ship reactor of advanced design and a power of 60,000 hp. The present tendency in commercial navigation to use high power is underlined by a detailed analysis of the development of transoceanic transportation of merchandise by container-carrying ships. (auth)

34149 SURVEY OF MARINE REACTOR CONCEPTS. Nishibori, Eizaburo; Nagamoto, Yoshio (Japan Nuclear Ship Development Agency). Nippon Genshiryoku Gakkaishi, 9: 267-72(May 1967). (In Japanese).

Various promising concepts of marine reactors developed in foreign countries are classified and reviewed. The salient features of each concept are briefly discussed, in particular reference to its use for marine propulsion. (auth)

Rocket and Space Reactors

Refer also to abstract 34075.

34150 (IDO-17203) RADIOLOGICAL ASPECTS OF THE SNAPTRAN-2 DESTRUCTIVE TEST. Cordes, O. L.; Bunch, D. F.; Fielding, J. R.; Warkentin, J. K. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Feb. 1967. Contract AT(10-1)-205. 51p. Dep. CFSTI.

Radiological information obtained from monitoring a planned destructive excursion of a modified SNAP 10A/2 reactor is described along with the sampling and analytical techniques used to obtain the information. An analysis of the data is included which indicates that only 21 percent of the fission products was released, that the radiation hazards were low, and that the beryllium from the reactor drums and reflectors did not produce a health hazard. (auth)

34151 (UCRL-70272) LARGE NUCLEAR-ELECTRIC SPACE POWER PLANT. Walter, Carl E.; Kolar, Oscar C.; Brown, Norman J.; Wilcox, Thomas P. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). May 12, 1967. Contract W-7405-eng-48. 47p. (CONF-670806-3). Dep. CFSTI.

For presentation at 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla.

The characteristics of a large Nuclear-Electric Space Power (NESP) plant are studied. To place the design study in context, a plausible manned mission to Mars is adopted. Mission requirements are such that the specific mass of the power plant must be 7 g/W and it must deliver 5 MW of electric power for about 10 months out of the 15-month duration of the mission. The Rankine cycle is adopted for this application. The nuclear reactor is contained within a primary loop consisting of the reactor, preheater, boiler, and pump. The reactor coolant is Li and the working fluid is K. The use of a flat heat-pipe radiator results in a relatively efficient, lightweight, and reliable system. The reactor material system is U nitride fuel, W alloy cladding, Li coolant, and BeO reflector. These materials are thought to be generally compatible with each other. Fuel element design was considered in detail. The selected "hybrid" fuel design provides redundant defense against fission fragment leakage into the coolant stream. Radial power distribution can be shaped by adjusting the reflector thickness, by spatially varying the enrichment of ^{235}U in UN, and by sizing the central coolant return pipe. (auth)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 32365, 32407, 32512, and 33858.

34152 (APDA-194) PRELIMINARY HYPOTHETICAL ACCIDENT ANALYSIS FOR FAST TEST REACTOR, INTERIM REFERENCE DESIGN CORES. Ball, G. L.; Nicholson, R. B.; Klickman, A. E. (Atomic Power Development Associates, Inc., Detroit, Mich.). Sept. 1, 1966. Contract AT(11-1)-865. 65p. Dep. CFSTI.

A preliminary comparative study of the maximum energy releases obtainable for each of two currently proposed interim reference design reactor concepts for the Fast Test Reactor, using the same basic calculational technique for each, is described. A criterion for the selection of a final Fast Test Reactor core design is given and a basis for a reasonable estimate of the maximum energy release which might be encountered with each concept is discussed. The energy releases for the interim reference design cores, a 600-liter PuO_2-SS cermet core and an 800-liter ceramic core, were calculated using a "Bethe-Tait-type" approach. This approach utilized simplified one-dimensional (spherical) geometry, assumed uniform core composition, and assumed instantaneous meltdown followed by gravitational collapse into more reactive uniform configurations. The resulting positive reactivity transients were terminated by core expansion based upon core hydrodynamics and the pressure of the vaporized fuel. The pressure-energy relations of the fuel were governed by equation of state parameters established by applying the law of corresponding states to high pressure data for light compounds. Doppler coefficients were factored into the calculations and, for the cermet core cases, the effects upon energy releases were calculated for the transient heat transfer between the PuO_2 particles and the surrounding stainless steel matrix. The energy available to do destructive work was determined by calculating the adiabatic expansions of the fuel following termination of the transients. Results for each core type are presented and the uncertainties inherent within each are discussed. Proposals are made for the refinement of the quoted results. (auth)

34153 (BLG-372) THE BR3 PRESSURE VESSEL IRRADIATION SURVEILLANCE PROGRAMME. EVALUATION OF THE FIRST AND SECOND CORE VESSEL STEEL SPECIMENS. de Meester, P.; Potemans, M. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Apr. 1966. 12p. Dep.

First and second core BR3 pressure vessel steel samples were tested after irradiation. The shift in N.D.T. 30 ft/lb for samples irradiated for an integrated dose of 5.5×10^{18}, 1.2×10^{19}, 9.5×10^{19}, and 2.2×10^{20}nvt was +30, +50, +140, and +200°C. It was concluded that the BR3 vessel is still safe. If, in the future, a drastic change would be observed, annealing of the vessel could be considered. (auth)

34154 (BNWL-427) PuO_2 GRAIN REACTIVITY EFFECTS. Czerniejewski, F. R. (Battelle-Northwest, Richland, Wash.

Pacific Northwest Lab.). June 1967. Contract AT(45-1)-1830. 22p. Dep. CFSTI.

A model for predicting k_∞ from basic cross-section data and from the size and composition of the experimental cell is described. Resonance self-shielding for individual particles is calculated from collision probabilities, and the balance equation is solved by Simpson's integration. When the terms of the balance equation are suitably arranged, iteration is necessary only in the thermal energy range. The method was not verified; however, since most of the usual simplifying assumptions have been removed, the results should be in reasonable agreement with measurements. The calculational method should be of value in predicting PuO_2 grain effects beyond the range of the experiments. (auth)

34155 (BNWL-SA-1127) FAST FLUX TEST FACILITY INSTRUMENTATION AND CONTROL PROGRAM. Swanson, C. D.; Wood, M. R.; Cone, R. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1967. Contract AT(45-1)-1830. 11p. (CONF-670314-5). Dep. CFSTI.

From Liquid Metal Instrumentation and Control Symposium, Idaho Falls, Idaho.

A description of the FFTF and its program objectives is given. Experiment facilities are detailed. Instrumentation requirements are outlined from operation and safety and testing and development aspects. The problems associated with in-reactor instrumentation are discussed at length. (M.L.S.)

34156 (EUR-3456.f) FABRICATION DE LA BOUCLE A LIQUIDE ORGANIQUE NO. 4. Rapport Final. (Fabrication of Organic Liquid Loop No. 4. Final Report). Pointud, R.; Franzetti, F. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). May 1967. 52p. (In French). Dep.

The construction assembly and preliminary tests on the BLO 4 loop which is operating in the pool reactor "SILOE" at Grenoble are described. A detailed description of the various components of the loop is given; a description of a mock-up for flux monitoring is presented; and the results obtained during preliminary tests in and out of pile are detailed. (M.L.S.)

34157 (IDO-17219) LOFT CORE DESIGN REPORT. Miller, C. S. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1967. Contract AT(10-1)-205. 159p. Dep. CFSTI.

The nuclear reactor for use in the loss-of-fluid test (LOFT) is designed to be representative of a large pressurized-water reactor except for size and power. The reactor operates with a power output of 50 megawatts at 2330 psi and at 545°F. The core is 36 in. long and has an effective diameter of 41.5 in. It is fueled with 52 elements, each containing 64 Zircaloy-clad, low-enriched UO_2 fuel pins. Reactivity control is provided by cruciform-shaped, boron-stainless steel control rods. (auth)

34158 (RFP-939) EMPIRICAL ANALYSIS OF SPHERICAL AND HEMISPHERICAL ASSEMBLIES OF ENRICHED-URANIUM METAL. Ernst, Bruce B.; Schuske, C. L.; King, Howard W. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). June 9, 1967. Contract AT(29-1)-1106. 4p. Dep. CFSTI.

A simple empirical equation has been found which relates the volume to surface ratio (V/S) to the critical mass of spherical and hemispherical shapes, reflected and moderated with oil. The equation is of the form: Mass = C/(V/S − B) + A, where A, B, and C are empirical constants. (auth)

34159 (TRG-Report-1416) AN ANALYSIS OF THE COMMISSIONING TESTS OF THE DELAYED NEUTRON MONITOR ON THE D.M.T.R. BOILING WATER LOOP. Etherington, E. W. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). Feb. 2, 1967. 22p. Dep. CFSTI. UK 2s. 6d.

The construction of the delayed neutron monitors in use with the boiling water loop in D.M.T.R. consists essentially of three BF_3 counters placed near to the steam/water separator. This provides a large reservoir with a short delay time from the in-pile section of the loop, ensuring a relatively large signal. The system was tested using the signal arising from ^{17}N and from the U contamination of the fuel cans and the results were compared with a detailed theoretical analysis of its operation. These tests established that the minimum detectable signal was that from a hole of effective area about 0.01 cm^2 at position of maximum flux. (UK)

34160 (USNRDL-TR-67-45) PULSED REACTOR SIMULATION OF UNDERWATER NUCLEAR EXPLOSIONS. Pestaner, J. F.; Love, D. L. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 13, 1967. Contract AT(49-7)-2886). 23p. Dep. CFSTI.

An underwater nuclear explosion was simulated by pulsing a 10 mg foil of enriched ^{235}U with thermal neutrons from the KEWB reactor. The purpose of the experiment was to produce the physical-chemical species of fission products as closely as possible to those produced in a real underwater nuclear explosion. Moving pictures and temperature measurements of the event showed that complete vaporization was not achieved, although melting did occur. (auth)

34161 CRITICALITY OF PLUTONIUM COMPOUNDS IN THE UNDERMODERATED RANGE, H : Pu ≤ 20. Hansen, L. E.; Clayton, E. D. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Nucl. Appl., 3: 481-7(Aug. 1967).

Experimental criticality data do not exist for most plutonium compounds. To obtain guidelines for nuclear criticality safety use, a survey utilizing transport-theory calculations was made to determine the critical masses of bare and water-reflected spheres as a function of density and H : Pu ratio for 12 of these compounds in the undermoderated range (H : Pu ≤ 20). The compounds considered were: PuH_2, PuH_3, PuN, PuC, Pu_2C_3, PuO_2, Pu_2O_3, PuF_3, PuF_4, $PuCl_3$, $Pu(NO_3)_4$, $Pu(C_2O_4)_2$. Also derived were core density exponents which permit critical masses to be predicted for compounds with densities ranging down to one-fifth of their theoretical values. The validity of the calculations was examined by comparing results with the limited criticality data on homogeneous PuO_2 systems in the undermoderated range. Comparisons were also made for Pu metal systems and for three heterogeneous Pu-fueled assemblies. (auth)

34162 OUTLOOK FOR THE DEVELOPMENT OF RESEARCH REACTORS. Haraga, C.; Mihaila, Al. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 19: 357-64(1967). (In Rumanian).

Current requirements of low-energy nuclear physics and of power-reactor development studies keep imposing an increase of the neutron flux of research reactors; at present, plans are made for reactors with a flux of 2 to 5 × 10^{15} n/cm^2 sec. Originally graphite or heavy-water moderated research reactors were used because they allowed the use of natural U; now, as enriched-U fuels are becoming generally available, water-moderated reactors are preferred, because they allow the improvement of the flux/power ratio. Recently, a research reactor with horizontal beamholes, designated as MIF, was designed at the I. V. Kurchatov Institute in Moscow. Comparison of this reactor with the American HFBR revealed that the Soviet design provides for two beamholes passing into the core, while the U.S. reactor has none. All but one of U.S. reactor beamholes have a smaller radius than the MIF. The power rating of the MIF is 20 MW, compared to 40 MW of the HFBR, but its thermal neutron flux is 5 times higher at the exit point of the beamhole because of the short length and large diameter of the channel. Design of research reactors requires a complex optimization, correlating the basic reactor characteristics with the intended use. (TTT)

34163 SIMULATION OF FISSION PRODUCTS IN FAST CRITICAL ASSEMBLIES. Schroeder, Rolf (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 10: 18-27(June 1967). (In German).

The fission product mixture to be expected in a reactor after a time of operation must, on a practical basis for measurements, be made in a critical assembly with stable elements. It follows that a part of the fission product nuclides are simulated by other nuclides. These are closely observed in the simulated portion as well as in the experimental, and in the resulting reactivity errors. A practical example is discussed. (tr-auth)

34164 SHIELDING PROBLEMS ON THE WWR-S REACTOR IN CONNECTION WITH THE PLANNED POWER-INCREASE FROM 2 TO 10 MW. Wetzel, L. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 10: 112-13(Apr. 1967).

In connection with the work to prepare the power-increase of the WWR-S reactor in the Zentralinstitut für Kernforschung Rossendorf some investigations have been carried out in order to determine how the given biological shield meets the new protection requirements. The obtained results show that only few points require additional shielding devices: non experimental horizontal beam tubes, movable plug on the reactor top, and thermal column. (auth)

34165 RESEARCH IN REACTOR PHYSICS BY TIME-OF-FLIGHT METHOD WITH REACTOR IBR. Zvonarev, A. V.; Morozov, V. N.; Nikolaev, M. N.; Orlov, M. Yu.; Parfenov, V. A. Kernenergie, 10: 101-6(Apr. 1967). (In Russian).

The results of neutron spectra measurements are given for the widely used reactor engineering materials, such as Ni, Fe, stainless steel, U metal, and UO_2. Measurements were carried out with reactor IBR by time-of-flight method with the resolution 0.04 to 0.063 μsec/m at 1 eV to 1 MeV. Experimental spectra are compared with results of multigroup calculations by S_n and P_n methods. The influence of cross-section resonance structure on neutron

propagation in media is studied, the detailed structure of spectra near resonance peculiarities, connection of leakage spectrum with the spectrum in the medium, the accuracy of the multigroup constant system used and its application. (auth)

Reactor Components, Fuels and Accessories

Refer also to abstracts 32441–32443, 32513, 32515–32517, 32519, 32520, 32841, 32847, 32936, 32972, 32975, 32986, 32992, 33006, 33501, and 34154.

34166 (AECL-2660) THERMO-ELASTIC EXPANSION OF FINITE CYLINDERS. Veeder, J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan. 1967. 21p. Dep. CFSTI. CAN $0.50.

The thermal expansion of finite cylinders is calculated by a numerical method using a power polynomial whose coefficients are found by a rigorous application of the boundary conditions and minimizing the total strain energy. Calculations were done for several length-to-dia ratios, and it was found that in every case (a) the greatest radial expansion occurs at the ends of the cylinder and (b) the radial and tangential stresses are everywhere tensile on the end-faces. Its relevance to circumferential ridging on the cladding of fuel elements is discussed briefly. (auth)

34167 (BNWL-418) CONVECTION HEAT TRANSFER IN MOLTEN CENTER OXIDE FUELS. Christensen, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1967. Contract AT(45-1)-1830. 28p. Dep. CFSTI.

Upward displacement of the molten zone in horizontally irradiated UO_2 fuel rods was observed and attributed to convection heat transfer in the liquid oxide. The displacement was correlated with the size of the molten zone through a derived virtual film coefficient for the $UO_2(s)-UO_2(l)$ interface. Results were also analyzed in terms of melt diameter and a dimensionless parameter which combines effects of molten zone size, volumetric fission rate, and fuel melting point. Practical implications of the results include the possibility that departure from verticality in a molten-center fuel may cause fuel rod warping because of an upward thermal skew resulting from convection heat transfer in the liquid portion of the fuel. (auth)

34168 (BNWL-SA-923) MAJOR FACTORS IN PLUTONIUM AND URANIUM FUEL FABRICATION COSTS. Burnham, J. B.; Deonigi, D. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1966. Contract AT(45-1)-1830. 20p. (CONF-661108-2). Dep. CFSTI.

From Atomic Industrial Forum's Annual Conference, Pittsburgh, Pa.

Results are presented of a study of the economic factors affecting the fabrication of Pu and U fuel elements. Subjects considered are use of high-exposure Pu, vibrational compacting vs pelletizing, effect of cost of shielding, price of Zircaloy tubing, cost of ^{235}U, effects of increased production rates on capital investment, and effect of interest rates on value of nuclear materials. It is postulated that, in 10 years, fuel fabrication costs of Pu-enriched fuel elements should drop to about $50/kg, and of U-enriched fuel elements to $40/kg. (P.G.C.)

34169 (CEND-3107-306) BURNABLE POISON ADDITIONS TO UO_2. Summary Report. Christopher, S. S.; Mahagin, D. E.; Koziol, J. J. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). May 1967. Contract AT(30-1)-3107. 101p. (EURAEC-1872). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Two 6% enriched UO_2 fuel elements containing 500-ppM B_4C were fabricated at Combustion Engineering and irradiated in the Saxton Reactor to burnups of approximately 1000 and 5000 Mwd/MtU at a peak specific power of 17.2 and 19.8 kw/ft, respectively. Nondestructive examinations showed that no gross dimensional changes in either of the irradiated fuel elements had occurred. Destructive examinations did not reveal significant axial movement of the B. A substantial radial B redistribution was observed, however, which was of similar magnitude in both elements. The effect of this radial B movement of η_f (ratio of neutrons produced to thermal neutrons absorbed) and $\Delta\rho$ (difference in reactivity of the core) was investigated with the THERMOS program and found to be insignificant. The out-of-pile investigation of the reaction of UO_2-B_4C at 1150 and 1850°C in open and closed systems showed that UO_2 and B_4C react to form UB_4 and CO_2. The UB_4 further decomposes to other B species. A combination of chemical reactions and in-pile diffusion controlled mechanisms tends to cause redistribution of the B. This redistribution of B is a strong function of the thermal gradient in the fuel elements. (auth)

34170 (WAPD-TM-694) SOME NOTES ON THE APPLICATION OF SYNTHESIS METHODS TO ELASTICITY PROBLEMS. Kaplan, S. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1967. Contract AT(11-1)-Gen-14. 34p. Dep. CFSTI.

Equations are derived for the application of the synthesis approach to the construction of approximate solutions of two and three dimensional elasticity problems using the solutions of one and two dimensional problems. An invariant imbedding type procedure is described for solving the equations. (auth)

34171 EFFECTS OF HEAVY WATER AS WORKING MEDIUM ON NUCLEAR POWER STATION CYCLES. Popovic, Aleksandar; Zdrale, Rajko. Nukl. Energ., 4: No. 1, 22-5(1967). (In Slovak).

The problems of choosing the most important parameters and characteristics of the equipment for the secondary cycle of nuclear power plants using heavy water as working medium are investigated. Particular attention has been paid to the selection of condensation pressure, feed water heating, feed water piping, and turbine reheating. The results have been presented of the technical and economic analysis of the most important parameters for a 250 MW(e) BHWR type nuclear power plant, and the influence shown of some variant solutions upon the economic indicators of the system as a whole. (auth)

34172 IDENTIFICATION AND MODELING OF STATES AND PARAMETERS OF NUCLEAR REACTOR SYSTEMS. Sage, Andrew P. (Univ. of Florida, Gainesville); Masters, George W. IEEE (Inst. Elec. Electron. Eng.) Trans. Nucl. Sci., NS-14: 279-85(Feb. 1967).

From 13th Annual Nuclear Science Symposium, Boston, Mass., Oct. 19–21, 1966. See CONF-661020.

The development and application of a method for on-line estimation of states and parameters in noisy nonlinear systems is presented. Requisite data for the method consists of a sequence of measurements on system output variables which are, in general, nonlinear functions for one or more of the system state variables. The output variables may contain random instrument errors and the system itself may be subject to random input fluctuations. There is no need to introduce special test inputs as the normal operating system inputs and outputs suffice for the sequential identification and modeling method proposed here. A discrete version of the startup dynamics of a thermal nuclear reactor system is considered. It is desired to estimate output states and parameters such that a best linear model as well as a best nonlinear model for the reactor states and parameters may be determined. A discrete version of Pontryagin's Maximum Principle is employed to obtain the canonic equations of the least-squares optimal estimator for the kinetics equations. A discretized invariant embedding technique is then applied to solve the resulting two-point boundary value problem. Finally, a system of sequential equations is obtained by application of variational methods to the optimal startup trajectory. The result is a sequential estimation scheme which has the advantage of direct applicability to discrete as well as continuous systems and which provides for the inclusion of certain higher-order terms not usually considered by other methods. As a result of these inherent features, the process has been found to provide a fast, stable estimate of the nuclear system variables. In addition, a minimum of a-priori statistical information is required. Experimental results, sequential estimator equations, data handling, storage, and other computational requirements are presented and discussed. (auth)

34173 CHEMISTRY IN REACTOR OPERATION AND FUEL DEVELOPMENT. Thiemann, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Atomwirt., Atomtech., 12: 254-5(May 1967). (In German).

Contributions to a symposium on reactor chemistry are briefly described. The tasks of the chemist in the fuel cycle, with investigations of fission gas release and with processes for the decontamination of radioactive effluent water are discussed. It is pointed out that the fuel cycles of advanced reactor types and the development of breeder reactor fuels are providing the chemist with new and extensive tasks in nuclear technology. (J.G.B.)

34174 INFLUENCE OF PYROLYTIC-CARBON CREEP ON COATED-PARTICLE FUEL PERFORMANCE. Prados, John W.; Scott, J. L. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Appl., 3: 488-94(Aug. 1967). (ORNL-TM-1787).

The Prados-Scott model for coated-particle behavior has been modified to include the effects of irradiation-induced creep on the stress-strain history of pyrolytic-carbon coatings. Calculations are performed in a stepwise fashion, with double trial-and-error iterations required for each time (or fluence) increment. Lack of accurate information on the mechanical behavior of pyrolytic carbons under irradiation still limits the quantitative applicability of

the results; however, the computational sequence has been designed to permit simple updating of mechanical behavior subroutines as more reliable data are obtained. Using the best available creep information, we found that the performance of typical pyrolytic-carbon-coated particles is significantly improved by creep under conditions of irradiation which will obtain in advanced high-temperature gas-cooled reactors. On the other hand, with the high burnup rates and low fast fluences characteristic of most coated-particle proof tests, the effects of creep are small and are likely to be undetectable. In such cases, an elastic model can be used effectively to predict failure. (auth)

34175 USE OF ON-LINE COMPUTERS IN BOILING-WATER-REACTOR POWER PLANTS. Bartu, A. S. (General Electric Co., San Jose, Calif.); Onsager, R. W. Neue Tech., 9: 146-51 (May 1967).

The process computer has become an integral part of the boiling water reactor and has done so on a sound economic basis. A method has been developed for using the computer in a way that gives substantial economic benefits without significantly affecting the plant availability. Use of the computer to monitor or automatically control the turbine-generator, and/or the nuclear boiler is not being recommended at present but may be desirable in the future. (auth)

34176 MEASUREMENT OF THERMAL CONDUCTIVITY OF SOLID MATERIALS, ESPECIALLY OF CERAMIC NUCLEAR FUELS AT HIGHEST TEMPERATURES. Spies, J. Ber. Deut. Keram. Ges., 44: 271-8(June 1967). (In German).

A method is proposed for the measurement of thermal conductivity of ceramic nuclear fuels at the fuel temperatures of 800 to 2000°C encountered in a high temperature reactor, which, physically, is based upon the one-dimensional heat flow method. A disc shaped specimen was heated on both sides by electron beams in vacuum. The temperatures of the sides of the specimen were measured accurately by a photoelectric pyrometer. The heat flow penetrating the specimen perpendicular to the disk areas owing to thermal conducting was determined by adjustment of two stationary states through the arising difference in the powers emitted onto a preset side of the specimen and reflected by it, respectively. The attainable accuracy in measurement of thermal conductivity is estimated to be ±5% for the case of measurement of heat flow through the powers dissipated by the specimen area. The apparatus can also be designed so that measurements of neutron irradiated nuclear fuel material in a hot cell are possible by remote control. (auth)

34177 IMPROVEMENTS IN FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Kernforschungsanlage Julich des Landes Nordrhein-Westfalen). British Patent 1,070,677. June 1, 1967. Priority date Oct. 22, 1964, Germany.

A fuel element for water-cooled or liquid-metal cooled nuclear reactors consists of carbides, oxides, or nitrides of fissionable materials coated with carbides, C, or BeO, contained in sealed cans of corrosion-resistant steel or zirconium alloy. A filler in powder form, having good heat conductivity, may be distributed over the fuel particles and neutron flux density may be controlled by adjusting the ratio of mixing between the fuel particles and filler. Spaces between the fuel particles may also be filled with an inert gas under pressure of 5 to 15 atm. (P.G.C.)

34178 METHOD FOR TIGHTLY CLOSING TUBES MADE OF CERAMIC-METAL COMPOSITE MATERIALS, FOR EXAMPLE SHEATHS FOR THE FUEL ELEMENTS OF NUCLEAR REACTORS. Agace, Carlo; Alfille, Lucien; Klersy, Raymond; Musso, Guiseppe; Parisotto, Angelo; Schrader, Karl (to European Atomic Energy Community). British Patent 1,070,204. June 1, 1967. Priority date Feb. 6, 1963, Belgium.

Techniques for closing, by separate plugs, the ends of metal-ceramic sheaths for nuclear reactor fuel elements are described. The process consists essentially of holding the plug on the tube mechanically or by electromagnetic swaging, and making a tight weld by one of several welding or brazing methods. Additional metal is supplied to the weld during the operation by a ring of the same metal as the metallic component of the composite material, i.e., Al for SAP tubes. (P.G.C.)

34179 NUCLEAR FUEL ELEMENT. (to Hitachi Ltd.). British Patent 1,070,138. May 24, 1967. Priority date Feb. 27, 1964, Japan.

A nuclear fuel element for use in a heavy water moderated reactor, containing light water or an organic coolant, was developed. The quantity of coolant in the assembly is kept at a minimum, to decrease void coefficients during operation of the reactor, by insertion of hollow tubes parallel with and between the fuel rods. The tubes are of material having a small neutron absorptive power and may be evacuated, filled with an inert gas, or MgO. (P.G.C.)

GENERAL

34180 (ANL–7321) PERFORMANCE STATISTICS OF THE FORTRAN IV (H) LIBRARY FOR THE IBM SYSTEM/360. Clark, N. A.; Cody, W. J.; Hillstrom, K. E.; Thieleker, E. A. (Argonne National Lab., Ill.). May 1967. Contract W-31-109-eng-38. 38p. Dep. CFSTI.

Testing procedures are described and results tabulated for accuracy and timing tests of the basic FORTRAN IV (H) Subroutine Library provided by the manufacturer for the IBM System/360 computer. (auth)

34181 (BDX–613–95) STRUCTURAL APPLICATION CHARACTERISTICS OF A RIGID URETHANE FOAM SYSTEM. Smith, C. H.; DeGisi, S. L. (Bendix Corp., Kansas City, Mo.). Oct. 1966. Contract AT(29-1)-613. 23p. (CONF-670904–3). Dep. CFSTI.

For Presentation at 154th National Meeting of the American Chemical Society, Chicago, Ill.

The effect of temperature on several physical properties of a rigid urethane foam system is reviewed. Foams at densities of 5, 10, 15, 20 and 25 pounds per cubic foot are included. The role of mold preheat temperature, isocyanate index and cure schedule on the compressive strength of the foam is also presented. Several aspects on the use of rigid foam for structural applications are discussed. (auth)

34182 (BNWL–415) LABORATORY EVALUATION OF DE-ENTRAINERS MADE FROM TEFLON AND POLYPROPYLENE FIBERS. Postma, A. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1, 1967. Contract AT(45-1)-1830. 29p. Dep. CFSTI.

Fiber beds of Teflon and polypropylene were evaluated for potential use in removing submicron aerosol particles from a gas stream. Ninety to ninety-eight percent of 0.3 micron diameter dye particles were removed by the Teflon fiber beds when dry, but the removal efficiency decreases to about 75% when wet by a spray. A polypropylene fiber bed removed 98% of 0.3 micron diameter dye particles when wet by a fine spray and offers promise in the removal of caustic particles from a saturated gas stream. (auth)

34183 (COO–1469-0039) RANDOM GENERATION OF SENTENCES FROM CONTEXT FREE AND CONTEXT SENSITIVE PHRASE STRUCTURE GRAMMARS. Report No. 215. Minow, Martin (Illinois Univ., Urbana. Dept. of Computer Science). Oct. 1, 1966. Contract AT(11-1)-1469. 70p. Dep. CFSTI.

Thesis.

A set of computer programs which generate sentences from context-free and context-sensitive phrase-structure grammars is discussed. Topics include the linguistic assumptions reflected in the context-sensitive phrase-structure grammars, the overall structure of the programs and their uses, and a series of appendices giving more detailed information. (B.G.D.)

34184 (COO–1469-0048) SYSTEM DESIGN FOR ARTRIX GRAPHICAL PROCESSOR. Report No. 219. Esch, John William (Illinois Univ., Urbana. Dept. of Computer Science). Jan. 4, 1967. 43p. Dep. CFSTI.

Thesis.

Artrix is a system designed for research into display systems. The basic property of Artrix is its ability to store and display graphic information and to do Euclidean construction all without the aid of a backup digital computer. This is accomplished by on-line processing of TV frames using digital control of analog signals. The Artrix Graphical Processor performs various functions such as communication with the operator by receiving push button commands and lighting indicators to inform the operator of its responses to those commands and of the state of the system; automatic on-line graphical processing, of which the end results are Euclidean construction; and synchronization of the rest of the Artrix system. (B.G.D.)

34185 (COO–1469-0049) HYBRID CIRCUIT DESIGN FOR THE ARTRIX GRAPHICAL PROCESSOR. Report No. 220. Oberbeck, Peter Ernst Rudolf (Illinois Univ., Urbana. Dept. of Computer Science). Jan. 7, 1967. 51p. Dep. CFSTI.

The design of hybrid circuits for the Artrix Graphical Processor, which is a high-speed on-line graphical processor capable of doing all Euclidian constructions without the use of a large digital computer is discussed. (B.G.D.)

34186 (EUR-3174.f) ETUDE SUR L'ASSURANCE "DOMMAGES MATERIELS" DES INSTALLATIONS NUCLEAIRES FIXES. (Study on the Insurance of Fixed Nuclear Installations). (Deutsche Versicherungs-Schutzverband e. V., Bonn (West Germany)). Feb. 1967. 234p. (In French). Dep.

The study covers the contracts for the insurance of nuclear installations, such as those concluded by nuclear insurers in the European Community, the United States, Great Britain and Switzerland. In particular, it deals with the coverage to be provided by nuclear insurance, the pertinent legal regulations, and in particular laws governing insurance contracts, criteria for determining premiums and an analysis of the insurance market. The study outlines the present state of affairs and also makes recommendations concerning possible improvements. (auth)

34187 (GEAP–5471) PAPA: STRUCTURAL ANALYSIS OF PLATES AND SHELLS USING TRAPEZOIDAL AND TRIANGULAR PLATE ELEMENTS. North, E. L. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Mar. 1967. Contract AT(04-3)-189. 46p. Dep. CFSTI.

An original approach to the plate-panel element based upon the concept of two intersecting beams connected at their center point is described. Poisson's ratio, not normally considered in beam analysis, is incorporated into the panel elements by equating strains in one direction to Poisson deflections normal to the strains. Work carried out on rectangular plate elements show that this method overcomes many of the limitations in most plate element approaches. A correlation between the computer plate element approach and the classical theory is presented. Also, cases analyzed using a shell-of-revolution solution for cones and the plate-panel element are presented. Results calculated using the plate-elements showed the required degree of accuracy. Although the analyses described are for relatively simple structures, the same degree of accuracy would be available in larger and more complex structures through the use of proper modeling techniques. (D.C.C.)

34188 (KAPL–P–3343) SHOCK ANALYSIS BY MATRIX METHODS. McCalley, Robert B. Jr. (General Electric Co., Schenectady, N. Y.). May 1967. Contract W-31-109-eng-52. 101p. Dep. CFSTI.

A method of calculating the forces exerted on a structure from shock motion by means of matrix notation and computer computation is presented. An example is presented that deals with a cylindrical vessel with hemispherical ends supported by a cylindrical skirt. Only lateral motion of the foundation is considered with system responses in deflection and rotation at the skirt top relative to the foundation, deflection and rotation of the tube bottom relative to the vessel, and rotation of the rod bottom relative to the vessel. Structural and mass properties of each item are computed. Mass and spring coordinates for the individual items are introduced and related to the final system coordinates by matrix transformations. The numerical equations of motion and their solution are generated by matrix manipulations within the computer and are described in detail. (D.C.C.)

34189 (NVO–235-1) RELATIVE SUSCEPTIBILITY TO WAVE INUNDATION AT THE HAWAIIAN ISLANDS AS DETERMINED FROM HISTORICAL OBSERVATIONS. Final Report. Adams, William Mansfield (Hawaii Univ., Honolulu). May 1967. Contract AT(26-1)-235. 63p. Dep. CFSTI.

The relative susceptibility of the Hawaii coastlines to inundation by ocean waves is studied. Some damage estimates are included, but these are not emphasized in the study. A search of meteorological records revealed that 2,086 storms lying to the Southwest of Hawaii occurred from 1910 through 1966. The separation of these storms into near storms and distant storms seemed appropriate to assure that the waves arriving at the islands were of uniform energy density. The near storms were not used. A method was developed for obtaining a relative susceptibility index for the waves presumed to be due to the distant storms. These indices were found to be derivable for azimuths which could not possibly have obtained significant storm wave energy. It was concluded that the resulting indices are not usable for waves on the periods of about 5 to 20 seconds. Having developed the susceptibility index method, it was decided, for comparative purposes, to apply it to tsunami data. This was done for four major tsunamis. The susceptibility index values appear to be meaningful when applied to tsunamis. Therefore, it is suggested that the tsunami susceptibility index values be used until a better method of analysis permits direct values to be obtained for shorter period waves. (auth)

34190 (ORNL–4138) ENGINEERING APPROACH TO MULTI-AXIAL PLASTICITY. Merkle, J. G. (Oak Ridge National Lab., Tenn.). July 1967. Contract W-7405-eng-26. 100p. Dep. CFSTI.

A straightforward derivation of the basic equations of plasticity is presented. The basic equations of plasticity are derived by using only calculus and vector algebra; tensor notation is not used. All

assumptions are explicitly stated. The flow rule is derived by two different methods. In one method the area under the effective stress-strain curve is assumed to equal the plastic work. For the other method the plastic material is assumed to be "stable." In both derivations the ratios of the principal plastic strain increments are uniquely determined by the state of stress at any point on the yield surface, except at a discontinuity. Plastic volume changes are related to the effects of hydrostatic pressure on the yield function. The equations of Hill's yield function and the Mohr-Coulomb yield function are examined. For anisotropic materials that obey Hill's yield function, the uniaxial stress-plastic strain curves in the principal directions must plot parallel to each other on log-log paper; this leads to a general method for determining the coefficients of anisotropy. The plastic volume changes associated with the Mohr-Coulomb yield function are examined. The tensile and compressive stress-plastic strain curves for Mohr-Coulomb material must also plot parallel to each other on log-log paper. Furthermore, the flow rules associated with the Mohr-Coulomb and the Von Mises yield functions can both be derived by assuming that slip causes no plastic strain in the direction of slip. Two example problems are solved: one uses Hill's yield function and the other the Mohr-Coulomb yield function. Present limitations and future extensions of the theory are also discussed. (auth)

34191 (ORNL-P-3135) APPLICATIONS OF THE MIXING EQUATION TO THE DISPLACEMENT OF POLLUTION FROM LAKES. Rainey, R. H. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 4p. (CONF-670616-1). Dep. CFSTI.

From International Symposium on Eutrophication, Madison, Wis.

An equation is presented which relates the buildup, or removal, of the pollution to the flow of water through a lake, the volume of the lake, and the amount of pollution added to the lake. The equation does not accurately describe the many complicated changes taking place in a lake system but it gives approximations that demonstrate many of the problems involved in the control of pollution. When the kinetics of other mechanisms are known, additional parameters can be added to the equation to improve the approximation. (F.S.)

34192 (ORNL-TM-1863) STATPAK. Hull, Norma C. (Oak Ridge National Lab., Tenn.). July 1967. Contract W-7405-eng-26. 176p. Dep. CFSTI.

Three classes of statistical computer programs which are available for use on the ORNL computers are described. The classes are: regression analysis, linear and non-linear; analysis of variance, for one-way classifications, for factorial experiments, and for three way classifications with multiple observations; and graphing programs. Some programs are modifications of the BIMD and BMD series written at the University of California at Los Angeles; some are original programs developed by the Statistics Section of the Mathematics Division; and others are modifications of programs prepared by personnel of other divisions of ORNL. (auth)

34193 (ORO-2572-11) EDDY-CURRENT-FREE SWITCHING OF PERMALLOY THIN FILMS. Watson, J. K.; Bourne, H. C. (Rice Univ., Houston, Tex. Dept. of Electrical Engineering). Mar. 1967. Contract AT(40-1)-2572. 20p. (CONF-670425-1). Dep. CFSTI.

From 5th International Magnetics Conference and Exhibits, Washington, D. C.

Results are presented from an experimental investigation of large-angle flux reversal of magnetic films. The reported measurements were made with an unconventional instrument with design features which are briefly outlined. Switching characteristics for a selected film are shown, and are compared with results of others in region II at 2° transverse bias. Our 6 oersteds-nanoseconds is an order of magnitude faster than others although the switching field rise time is an order of magnitude slower. Conventional switching characteristics are shown to be made by transversals of measurements across a two-dimensional field plot of the film characteristics. The width of region II, the lower threshold for region II, and the independently measured dispersion field are all approximately 0.1 oersted for the subject film. (auth)

34194 (ORO-2572-12) MACHINE-ORIENTED LOGIC INCORPORATING THE EQUALITY RELATION. Sibert, Elbert Ernest Jr. (Rice Univ., Houston, Tex. Dept. of Electrical Engineering). May 1967. Contract AT(40-1)-2572. 81p. Dep. CFSTI.

Thesis.

A system of first-order logic is developed which is intended to provide a basis for the design of efficient mechanical procedures for proving theorems in whose formulation the equality relation is used. The approach used is based on the fact that the equality relation determines a congruence of the terms and literals arising from a given statement. The system contains three rules of inference, the first of which consists essentially of the application of the resolution principle to congruence classes of literals. The second and third rules are applied only to expressions consisting entirely of equations and denials of equations. The second rule is a rather complicated inference involving a large number of applications of the transitive property of equality; and the third rule is a relatively straightforward application of the universal substitution property of equality. The system is shown to be complete in the sense that any logically false sentence can be refuted with a finite number of applications of these rules of inference. Some principles for detecting superfluous inferences are also presented, and the completeness of procedures utilizing these principles is demonstrated. (auth)

34195 (SC-CR-67-2532) NUMERICAL SOLUTION FOR THE FLOW FIELD OF A SUPERSONIC CONE-CYLINDER ENTERING AND LEAVING A BLAST SPHERE DIAMETRICALLY. Eaton, Roger R. (Sandia Corp., Albuquerque, N. Mex.); Zumwalt, Glen W. (Oklahoma State Univ., Stillwater). May 1967. Contract AT(29-1)-789. 109p. Dep. CFSTI.

An analysis was performed to develop a method by which the flow field about a cone-cylinder configuration could be defined as it entered into and exited from a large radius spherical blast diametrically. The flow was approximated by solving the controlling partial differential equations using a numerical technique first proposed by V. V. Rusanov and extended here to account for real gas effects. Boundary conditions were developed for a 13.347-degree half-angle cone-cylinder which entered and exited from a shock front of strength 22.05 pressure ratio. The stream Mach number of the various phases ranged from 1.7 to 6.9. It was found that the flow in question could be approximated by the numerical technique, although the accuracy of the results decreased as the free-stream Mach number increased. (auth)

34196 (SC-DC-66-2423) GOVERNING DIFFERENTIAL EQUATIONS OF PROJECTILE PENETRATION. Thompson, L. J. (Texas Agricultural and Mechanical Univ., College Station). Dec. 1966. Contract AT(29-1)-789. 41p. (CONF-670701-3). Dep. CFSTI.

From 3rd Pan-American Conference on Soil Mechanics and Foundation Engineering, Caracas, Venezuela.

An overall study of the process of projectile penetration into soil is presented. The governing differential equations for the soil target medium are developed using the equations of motion and the continuity condition. Constitutive relationships are derived from Mohr–Coulomb theory for a rigid plastic material and from viscosity theory. The other necessary equations are generated from experimental investigations of the penetration mechanism. (auth)

34197 (SC-DC-66-2424) EMPIRICAL RELATIONSHIPS FOR OGIVAL PROJECTILE PENETRATION. Benson, Fred J.; Rohani, B. (Texas Agricultural and Mechanical Univ., College Station). Dec. 1966. Contract AT(29-1)-789. 23p. (CONF-670701-1). Dep. CFSTI.

From 3rd Pan-American Conference on Soil Mechanics and Foundation Engineering, Caracas, Venezuela.

The results of analysis of the time-acceleration traces for cylindrical ogival nose projectiles penetrating a soil medium are presented. The projectiles impact the soil medium at angles approximating 90 degrees. Relationships between acceleration, velocity, and penetration are discussed, and an approximate method of computing the maximum depth of penetration is presented. (auth)

34198 (SC-DC-67-1753) SUBSYSTEM TEST DATA ANALYSIS BY DIGITAL COMPUTER. Negrin, Alan E. (Scientific Data Systems, Santa Monica, Calif.). June 28, 1967. Contract AT(29-1)-789. 28p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

The combinations of analog and digital signals used in complex aerospace and industrial subsystems testing and the complex interdependences existing between channels make test performance analysis very difficult. As a result, most analyses are made by means of oscillographic recordings. This includes the inherent inaccuracies of the oscillographic methods, the element of human error, and the time requirement for analyzing oscillographic recordings. A general-purpose digital computer system is described which provides a better testing method with speed, reliability, and accuracy. This data acquisition-data analysis system utilizes an SDS 92 general-purpose, integrated-circuit digital computer with 32,768 twelve-bit words of core storage, console typewriter, paper-tape reader and punch, magnetic-tape unit, and card reader. (D.C.C.)

34199 (SC-DC-67-1788) THE POISSON APPROXIMATION TO THE BINOMIAL AS A RELATION BETWEEN THE PERCENT

POINTS OF THE BETA AND GAMMA DISTRIBUTIONS. Steck, G. P. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 11p. (CONF-670809-1). Dep. CFSTI.

For Presentation at 36th Session of International Statistical Institute, Sydney, Australia.

Two series relating the percentiles of the beta distribution, the percentiles of a related chi-square distribution, and the binomial sample-size parameter required for a given cumulative binomial sum are obtained from an expansion of a real double integral. The four other possible expressions relating these three quantities, each expanded in powers of each of the others, are derived. The motivation throughout is to have equality between cumulative binomial and Poisson sums. (J.F.P.)

34200 (SC-DC-67-1833) DISTORTIONS OF CONTROLLED TRANSIENTS BY SHOCK MONITORING SYSTEMS. Brooks, R. O.; Guzman, J. A. (Sandia Corp., Albuquerque, N. Mex.). June 1967. Contract AT(29-1)-789. 46p. (CONF-670903-4). Dep. CFSTI.

For Presentation at 22nd Instrument-Automation Conference and Exhibit, Chicago, Ill.

A method was developed to electronically generate controlled clean and noisy transients. These transients are used as substitutions of possible accelerometer outputs that may occur during shock tests. The electrical transients are fed into different shock monitoring instrumentation circuits, some of which distort the signals producing zero shift and/or filtered pulse distortions, thereby affecting record interpretation. The noisy transients have revealed that sometimes there are circuit deficiencies not found using comparable sustained wave or clean simple pulse signals. (auth)

34201 (SCL-DR-67-53) USERS' GUIDE TO DAPT (DIGITIZED APT). Quock, H. (Sandia Corp., Livermore, Calif.). June 1967. Contract AT(29-1)-789. 50p. Dep. CFSTI.

The use of DAPT, which is a Fortran program that generates an APT (Automatically Programmed Tools) part program from a deck of punched cards produced by a coordinate digitizer is explained. An example problem is included. (auth)

34202 (UCID-15144) COMPUTER PROCESSING OF PHOTOGRAPHIC INFORMATION. Conn, Richard W. (California Univ., Livermore. Lawrence Radiation Lab.). May 15, 1967. Contract W-7405-eng-48. 12p. (CONF-670403-2). Dep. CFSTI.

From Joint Computer Conference, Atlantic City, N. J.

Some experiments in digitizing photographs and subsequently reproducing them on a computer-controlled microfilm recorder are described. An appraisal of these experiments is given. (auth)

34203 (UCRL-13280) DEVELOPMENT OF AN INJECTION MOLDING PROCESS FOR PRESS PARTS. Final Report, July 1, 1966–December 31, 1966. Salyer, Ival O.; Ball III, George L.; Welch, William E. (Monsanto Research Corp., Dayton, Ohio). Jan. 1967. Contract W-7405-eng-48. 18p. Dep. CFSTI.

For Univ. of California, Livermore.

Sled retraction, intrusion molding, and decompression features were added to the HPM 450-IX-20 screw type injection molding machine. These features allow the molding of parts of greater size than the 20-oz capacity of the machine and provide for better control of the plastic prior to injection. A multi-circuit steam manifold was designed, constructed, and installed for operation with the HPM-IX-20 screw type injection molding machine. The manifold provides eight solenoid-activated, independently controlled steam-heating and cooling lines required for the press part die. The color stability of Merlon M-60, 9950 green, transparent polycarbonate in the visual region was shown to be adequate to be used for visual identification of parts by color. Difficulties were encountered in molding the green, transparent Merlon M-60 polycarbonate, causing high torque values and increased screw-return times. Solution and melt viscosity data did not indicate significant rheological differences between the newer, green Merlon M-60 and an older clear batch purchased during the first quarter of 1966. However, the melt viscosity of Lexan 131 polycarbonate was significantly lower than that of either lot of the Merlon M-60. A knuckle gage was installed, calibrated, and made ready for operation. (auth)

34204 (UCRL-13299) DYNAMIC STRESSES IN 24-INCH BALL VALVE. Report Number 4500-95-7-R2. Younger, F. C. (Brobeck (William M.) and Associates, Berkeley, Calif.). May 1967. Contracts W-7405-eng-48; 7931903. 112p. DTIE.

For California Univ., Livermore. Lawrence Radiation Lab.

Results of calculations of stresses in the 24-inch ball valve due to dynamic loading are reported. Such loading produces stress oscillations at a multitude of natural frequencies and mode shapes which have been calculated. A summation of the stresses due to each mode has been made. It is concluded that the local weak spots are the base of the valve protector and the supports for the trunnion hubs and that an overall mode of failure that is likely from external pressure is buckling of the housing shell. Redesigning of local weak spots is recommended. To prevent buckling of the housing, several reinforcing rings are recommended. (auth)

34205 (UCRL-16398) ANALYTICAL METHODS IN BACTERIAL KINETICS. Edwards, Victor Henry; Wilke, Charles R. (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 27, 1967. Contract W-7405-eng-48. 408p. Dep. CFSTI.

Thesis.

The development of methods useful in the study of the kinetics of bacterial growth and metabolism is discussed. A comprehensive review of the literature of mathematical models for bacterial growth is given. A computerized method for the analysis of batch culture kinetic data is presented that fits a generalized logistic equation to the data. The fitted equations are useful for interpolation, integration, differentiation, and other manipulations of the data. In the second part of this work, experimental data obtained with a salt tolerant strain of sulfate-reducing bacteria grown in both batch and continuous culture is presented, and a novel continuous culture apparatus is described. The data, which were taken for use in evaluation of the feasibility of projects using these bacteria, are analyzed using the computer program developed in these first part of this work. The results are correlated and discussed in relation to some of the proposed models. A sophisticated apparatus for measuring bacterial cell size-concentration distributions is described. The technique, based on a resistance principle, is shown to differentiate between normal cells and heat-killed cells, a result that should be of considerable use in the study of bacterial sterilization kinetics. The apparatus is calibrated and used in obtaining information on the cell size under a variety of experimental conditions. A computer program for the analysis of the computer-coupled output is presented. The system described will provide a powerful tool in the study of microbial kinetics. (auth)

34206 (UCRL-70247) SHOCK-WAVE STUDIES IN CONDENSED MEDIA. Duff, R. E.; Gust, W. H.; Royce, E. B.; Mitchell, A. C.; Keeler, R. N.; Hoover, W. G. (California Univ., Livermore. Lawrence Radiation Lab.). June 1, 1967. Contract W-7405-eng-48. 15p. (CONF-670914-6). Dep. CFSTI.

From International Symposium on the Behavior of Dense Media Under High Impulsive Pressures, Paris, France.

A brief survey is presented of several recent shock wave investigations of material properties at high pressures. A summary is given of some recently observed dynamic phase transitions in metals and ionic crystals with implications in static high-pressure scale calibration. The applications of some of the principles of modern optics to shock wave experiments are outlined. Direct measurements of shock velocity, particle velocity, and sound speed in a shocked material are described and illustrated. (auth)

34207 (Y-DA-1592) AUTOMATIC ERROR CORRECTION PERMITS CONVERSION OF 66 INCH BORING MILL INTO PRECISE INSPECTION MACHINE. Schede, R. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Apr. 4, 1967. Contract W-7405-eng-26. 17p. (CONF-670907-1). Dep. CFSTI.

For Presentation at 8th International Machine Tool Design Research Conference, Manchester, England.

The automatic error correction work on a 66-in. boring mill is presented. This includes straightness correction along the horizontal axis of the boring mill and rotary table runout and wobble correction. Automatic error correction work on fabrication machines has also been started. A numerically controlled machine is needed to fully realize all the benefits although tracer machines could be helpful in certain cases. In addition to the geometric errors corrected for on the boring mill, spindle growth due to thermal expansion, tool holder distortion, and part temperature are errors being investigated. The errors are corrected on a numerically controlled machine by introducing an error pulse in addition to the command pulse. With the present cost for the instrumentation required for automatic error correction, it is probably more economical to provide a mechanically better machine than to provide the corrective instrumentation on a new machine. (D.C.C.)